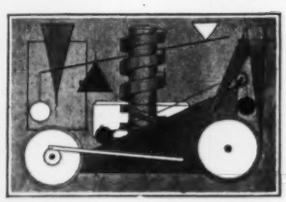
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 **January, 1932** **Number 1**



Next MONTH

THOUGH abundant data have been published on the subject of gearing, little authentic information has appeared on worm gear efficiency. The latter has been accorded some attention but in most cases conclusive results have been scouted.

MACHINE DESIGN *therefore believes readers will welcome the announcement of a two-part series dealing comprehensively with efficiencies of worm and parallel shaft gearing. The articles have been prepared by an authority and are based primarily on recent tests. Part I is scheduled for next month.*

L. E. Jermy

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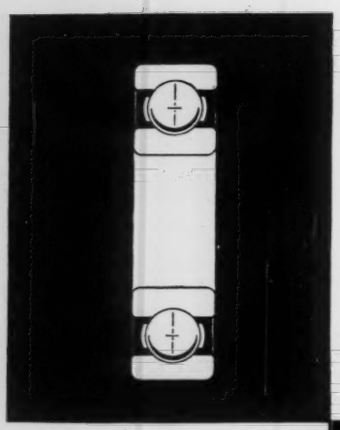

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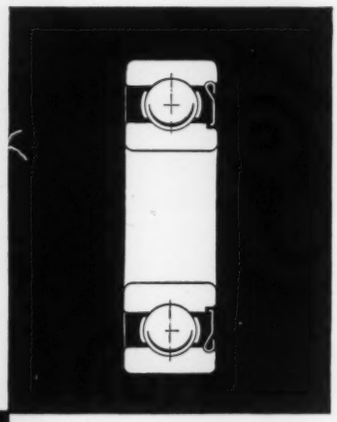

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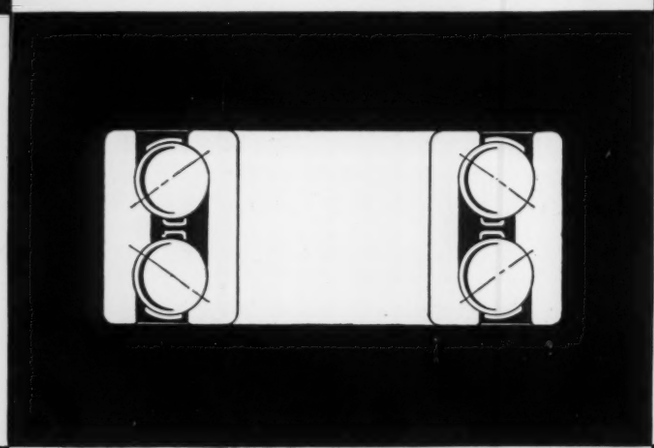

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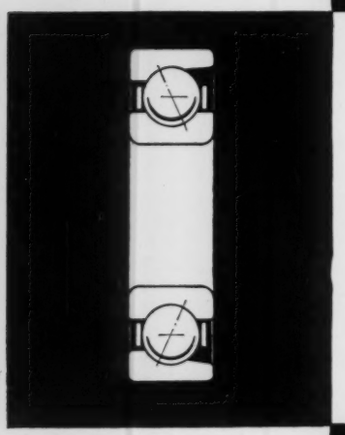

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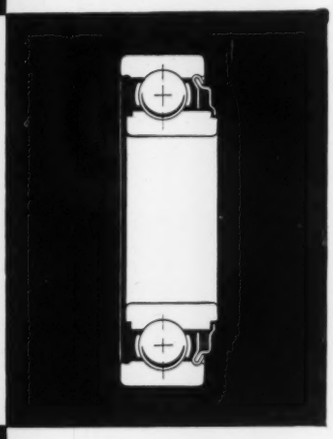

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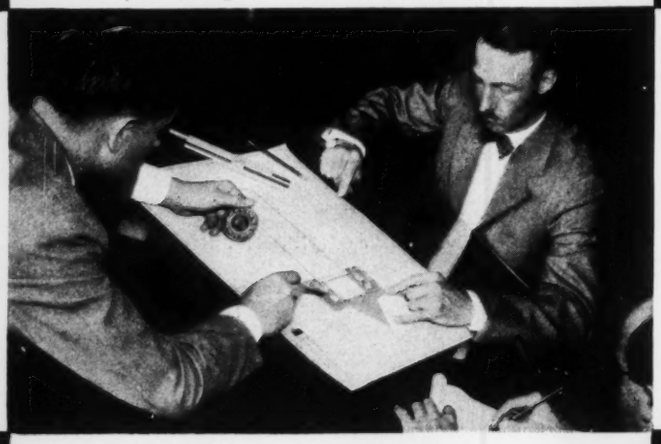

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Itemized Index, January, 1932

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

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FOR those of our readers who wish to have bound in one volume, the 12 issues of 1931 with indexes, that is the usual contents index and also the combined itemized index, a limited number will be available at $9 each plus postage, or $6 if the 12 issues are furnished by the reader. The volume is attractive as well as durable. It is bound in black and red leatherette, imprinted in gold. MACHINE DESIGN, Penton Building, Cleveland

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MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

January, 1932 Vol. 4—No. 1

Auto Shows Reveal New Trends in Mechanical Design

By Austin M. Wolf

Automotive Consulting Engineer, New York

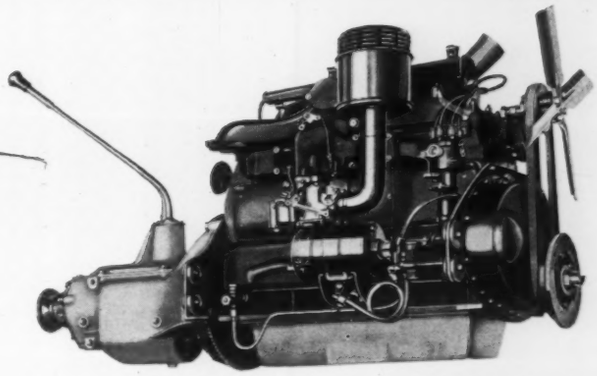


Fig. 1—Power plant incorporates thermostatic control of intake riser heating by utilization of the exhaust gases

DESIGNERS in the automotive industry have been called on to develop new standards of style, performance, reliability and ease of operation to create the "urge to buy." Accomplishment of such an aim is the measure of successful designing, assuming of course that prices remain as attractive as mechanical features. The engineers have made this possible, offering values unapproached by any other industry. Ideas utilized to reach their goal have been outstandingly progressive and many of them have wide application in machinery of practically every type.

An instance of this may be found in the concerted effort which has been made toward the ease or simplification of control. The Bendix vacuum clutch control introduced this past summer serves as the basis of the Buick, Cadillac, Chrysler and Marmon, systems in which a foot button controls a valve in series with one actuated by the accelerator pedal and another presenting varying sized orifices in the vacuum line according to the position of the gear shifting rods, as described in the December issue of MACHINE DESIGN.

These cars have speed-synchronizing clutches in the transmission and a torque-tube mounting to the rear of it. A free-wheeling unit in or at the rear of the transmission would result in too much complication. Hence the clutch control which in addition allows coasting with the clutch "out" as an equivalent to free-wheeling. This same reasoning applies to the Ford. Due to the increased coasting periods that will be indulged in, the throw-out and pilot bearings have been increased in capacity.

The previously described construction retains the basic machine elements and adds supplementary parts. Conceived along different lines is the Powerflo self-operating clutch in which the basic members are modified. The customary

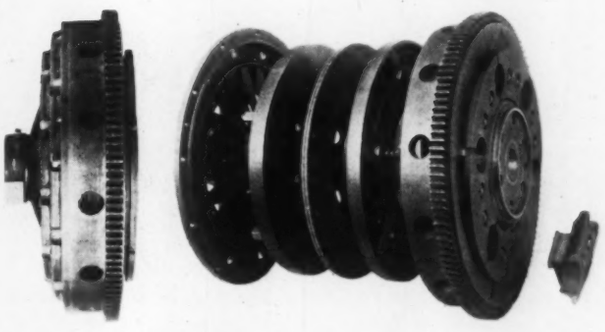


Fig. 2—Self-operating clutch, shown disassembled at right. Note individual weight

pressure springs in this case hold the friction disks apart. Arc-shaped weights are carried near the periphery of the flywheel and under centrifugal force the weights bring the friction disks together. This process starts around 400 revolutions per minute and complete engagement occurs at 700 revolutions per minute. Under ordinary road conditions, the shift lever can be left in "high." When the engine idles, the vehicle stands still and in accelerating the engine, an exceptionally smooth engagement results. When retarding the car with the brake, the drive disconnects itself automatically without resource to a pedal. Durable, moulded friction faces have made this clutch possible and its performance in bus and truck work assures its feasibility. Thorough air circulation through the clutch to dissipate heat is obtained by bending a portion of the throw-out fingers to form a fan vane and by providing discharge holes in the periphery of the flywheel over the friction surfaces.

Free-Wheeling Mechanisms Are Changed

To provide easy gear shifting, most transmissions now are provided with a cone clutch speed synchronizing means and a complete free wheeling unit at the rear of the transmission. The former avoids gear clashing and the most popular form consists of a cone sleeve yieldingly carried on the positive clutching member through a series of radial ball locks under spring pressure. The latter is a distinct trend in the new cars, allowing free wheeling in all forward speeds and requiring the use of the clutch pedal only in starting or reversing. The free wheeling action usually is under the control of a lever on the instrument board to make it effective or to lock it "out." When shifting into reverse, the unit is locked "out" automatically and compresses a spring in so doing. The return of the gear shift lever to neutral will bring back the overrunning clutch to the free wheeling position. Whereas last year's designs had ratchet units consisting of three sets of three graduated roller diameters, today's vogue is the use of six or eight rollers in individual pockets. Furthermore the cam shape on which the rollers ride has been redesigned for a reduction in wedge angles, reducing slippage and providing easy engagement. This type of clutch or ratchet mechanism, Fig. 7, has found some use in industrial applications and steadily is becoming more popular for this purpose.

Another lever that has been added to the instrument board or located on the steering column is the "ride" control. By means of a rod and shaft or cable arrangement similar to a four-wheel brake hook-up, the effective by-pass orifice of all four hydraulic shock absorbers is varied. The resistance can be changed to suit different load, road or speed conditions. The Houdaille shock absorber, however, provides an automatic regulation in that the by-pass discharge is through a sharp edge orifice which builds up resistance with increased turbulence besides being effective in turning a valve against the spring action of a thermostat-bimetal coil which compensates for changes in temperature.

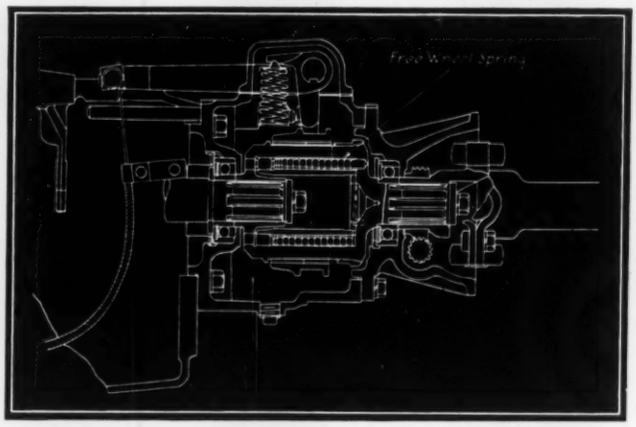


Fig. 5—Free-wheeling units of coil spring type

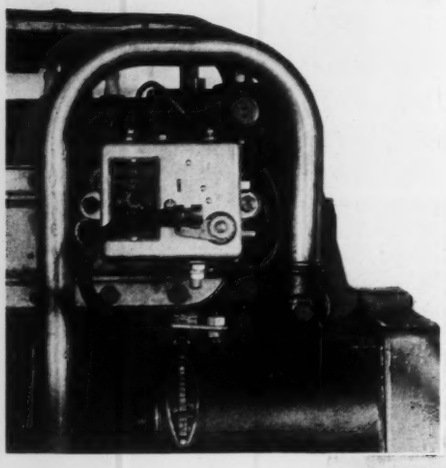
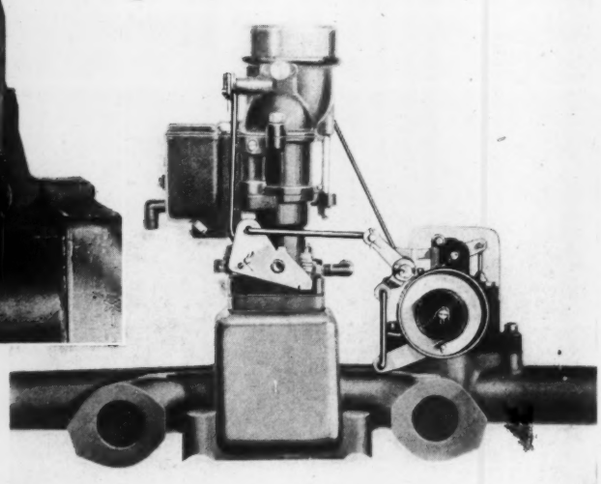


Fig. 3—New starting switch which combines with ignition. Engine starts when key is turned, and restarts if stalled

Fig. 4—(Below)—Thermostatic choke control which opens and closes choke valve in accordance with temperature of carburetor housing



Further means of simplifying control consists of thermostatic actuation of the choke, Fig. 4, sensitive to exhaust manifold heat. The hot and cold air passes to the carburetor in proportion

to the exhaust heating of the intake riser.

A new starting switch, Startix, Fig. 3, is combined with the ignition. When the key is turned "on" the engine is started automatically, repeats if the engine fails to continue running and also restarts if the engine stalls at any time. This is all done by solenoid control. By utilizing the depression in the intake manifold, or above or below the carburetor throttle, Delco Remy has evolved several automatic systems of spark advance or retard which is used in conjunction with the centrifugal advance control. A chamber houses a diaphragm subjected to the vacuum, which is opposed by a spring.

Fig. 6—At top are shown cross sections of brake rim before and after centrifusion. Note bond between steel and iron. (Below) — Complete single brake drum

After clutch control, much thought has been given to brake drums, Fig. 6. The ordinary low carbon, stamped steel drum has been discarded due to its scoring, inability to hold its size and shape, and its poor heat dissipating ability. Free wheeling has thrown more work on the brakes and improvements were imperative. The "Centrifuse" drum is a clever development in design and manufacture. A rim is first formed having two external flanges centrally located and an in-turned flange at each side. The latter form a trough which holds the poured cast iron when the rim, at white heat and "fluxed," is rotated at high speed. When cold, the rim is machined internally and cut at the center; then each half is projection welded to its backplate, resulting in two brake drums. Cast iron has proved itself in heavy duty work to be a most desirable drum material and in this design it is combined with maximum lightness and rigidity.

The Kelsey-Hayes drum also consists of a separate rim welded to a backplate. A strip of hot rolled, mill section alloy steel having several ribs is hooped into a circle, then welded, machined to size and normalized. A grain structure is developed which is difficult to score.

Designers have given considerable thought to

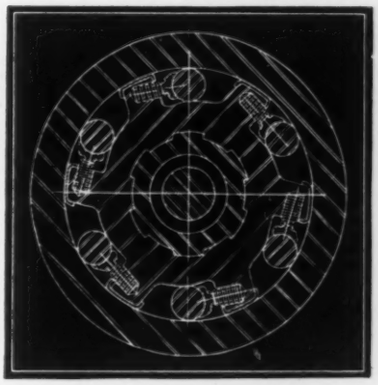


Fig. 7—Roller type of free-wheeling mechanism this year embodies single rollers in individual pockets. Cam angle also has been reduced to eliminate possibility of slippage

rigidity to give the body a suitable foundation to rest upon. Box section cross members are popular and mark the inception of welding in chassis frame construction. The future holds great possibilities for it but no doubt frame design will evolve along revolutionary lines. Pierce-Arrow has a box-section side rail from the center cross member forward. An opposed channel member is located within the rail, being secured thereto by cold riveting and arc welding.

Combats Torsion of Frame

The body reenforces the frame which is torsionally weak ahead of it and to combat this Packard and Pierce-Arrow tie the fenders and their brackets to the radiator shell by means of a brace at each side which supports the headlamps. The usual fender tie bar is retained. A heavy V bracing spaces the radiator shell from the dash and the hood also acts as a deep channel brace since most hood fasteners now are of the type that lock the hood sides against the dash and the radiator shell. In this way the entire front end structure is tied together in itself and with the cowl. Packard goes further in thwarting torsional frame movement by means of a "harmonic front-end stabilizer" at each end of the front bumper which consists of a lead weight on a cast iron core fitted with oilless bushings, sliding on a vertical rod between two sets of calibrated concentric springs. This serves as a mass of definite frequency to dampen out frame movements.

Hood doors have supplanted louvres, giving elegance and under-hood temperature control. The Graham Blue Streak, Fig. 8, is using a hood design which departs from old tradition and sets a new style. The radiator shell is essentially visible from only the front and the hood carries an unbroken sweep in side view by eliminating the stereotyped shell width. This should furnish an inspiration to many applications where sheet metal can adorn in modern form an ancient heritage of design. The Graham fenders also set a new fashion by concealing the chassis and running gear.

Of greatest interest is the number of new twelve cylinder engines and the Ford Eight.

Compression ratios remain at conservative values except in a few cases. A high compression head is standard on several engines which can be converted to low compression by the use of a thick gasket whose strength is maintained by a steel liner acting as a core within the asbestos-copper covering. Molybdenum chromium, electric furnace cast iron has been introduced for cylinder blocks and pistons.

Develops Copper-Cooled Valves

The copper-cooled exhaust valve is an important development. Copper is forged centrally into the valve stem and head, conducting heat away from the latter. To get greater mileage between valve grindings and to save the block material, inserted exhaust valve seats are used in a number of heavy duty engines. The material remains hard at elevated temperatures and consists of steel alloyed with tungsten, silicon, chromium, vanadium or cobalt.

Accoustics play an important role at two points other than the body insulation previously described. By changing the angular spacing of the blades, the fan noise is blended with other power plant noises of a less objectionable character. Another manufacturer attacks the problem by making opposite blades of his four-blade fan of different widths, so the vibrations of different frequencies tend to control each other. The Burgess "through-type" muffler, consisting of a perforated tube surrounded by a sound absorbing material, is used in greater numbers as an intake silencer and exhaust muffler. The latter now is being made with two tandem sections having different sound characteristics so that audible vibrations are heterodyned to a low inaudible beat. One high priced car uses mica in the front section and steel wool in the rear.

Vapor lock is obviated by running the fuel line on the outside of the frame opposite the exhaust side, where it is subjected to cooling draughts. Where exposed under the hood, it is covered with heat insulation. To draw cool outside air into the carburetor, Buick provides a door scoop at the front of the hood which can be opened or shut at will. A combination fuel pump and vacuum booster has been developed, the latter maintaining a constant suction for the windshield wiper regardless of speed or throttle opening. A diaphragm actuated from the camshaft is subjected on one side to the manifold vacuum. This in turn determines its stroke which is greater as the depression decreases.

More flexible rubber mountings are used and in greater number. Invariably there is an additional support back of the transmission and under the free-wheeling unit, resting on a cross member at this point.

It is evident that no depression has struck the engineering departments of the automotive industry. The new vehicles contain a far greater number of improvements than any previous year's offering and the success and stability of the industry shall continue because of its continued policy of giving the public the greatest value per dollar. This can all be traced back to its origin—the drawing board.

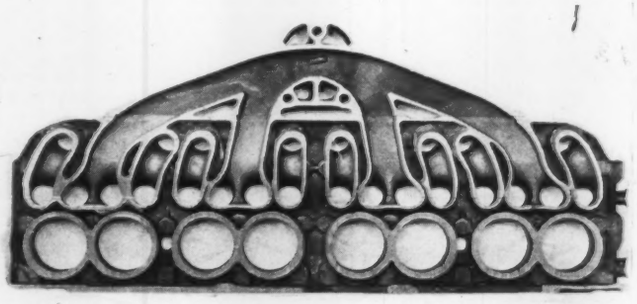


Fig. 9 — (Above) — Section through block for eight-cylinder engine. Note that portion of the manifold is continued in the cylinder block

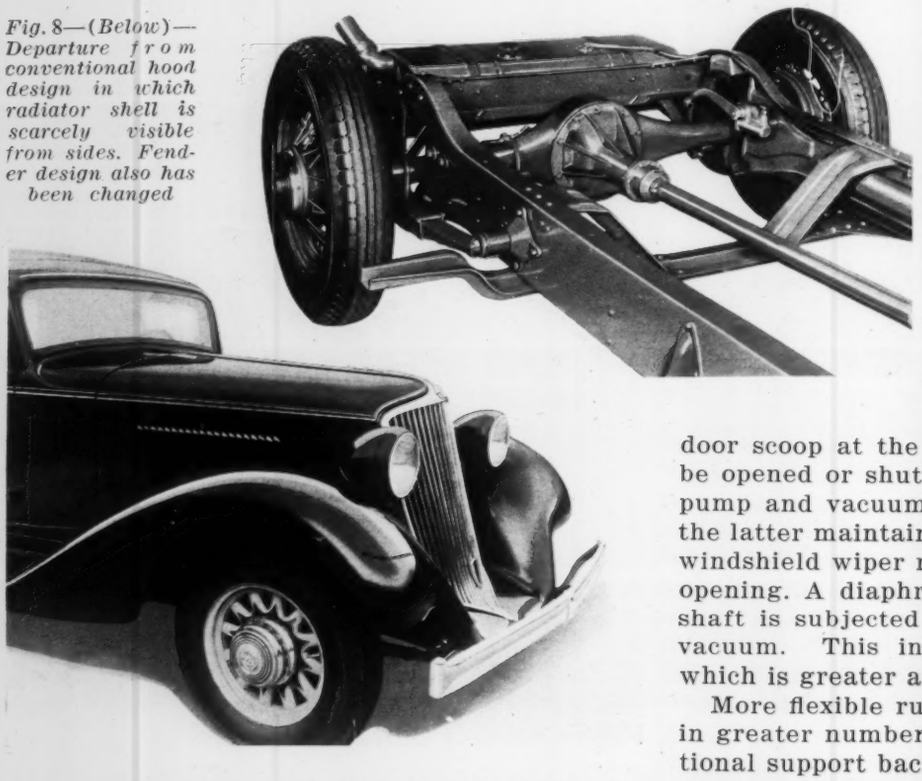


Fig. 8—(Below)—Departure from conventional hood design in which radiator shell is scarcely visible from sides. Fender design also has been changed

Fig. 10—(Left)—To obtain low body weight this frame has been provided with banjo enlargement with center removed. Rear axle extends through with adequate clearance for full spring action. Car can be raised by placing jack under rear tip of frame

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Electronics Simplify Machines

SURVEY of developments in the field of mechanical design with particular attention to incorporation of ideas which have possibilities in other fields discloses that applications of the photoelectric cell continue to expand in scope. One of the recent instances where this unit again has proved its versatility is in a conveyor scale which totalizes the weight of materials transported. This type of weighing unit is manufactured by John Chatillon & Sons, New York. When it was designed two years ago an electro-magnetic device was employed for converting electrical impulses into units of weight. (MACHINE DESIGN, Sept., 1929).

The photoelectric integrator embodying what is known as the radiovisor, a product of the Burgess Battery Co., New York, makes use of the conventional light sensitive cell, amplifying tube and relay in connection with a "light chopper," the outstanding feature of the unit. As shown in Fig. 1, the chopper is a cylindrical form with one end closed, mounted on a vertical shaft. In the surface of the cylinder are 32 slots. The first one is equal in length to the distance traveled by the beam from zero to full load. Each succeeding slot, 2, 3, 4 etc. up to the thirty-second, is shortened an equal amount at the bottom so that a line drawn from the bottom of the first and longest slot, around the cylinder to the bottom of the last and shortest makes a helix.

Covering the photoelectric cell is a bakelite tube in which a small hole is drilled directly opposite the sensitive plate of the cell. Condensing lenses focus the light on this hole, the chopper rotating between the light and the tube and alternately admitting and intercepting the light ray entering the hole. Each admission of light sets up a current which is broken by the interception, producing impulses which in this case operate the driving units of the register or recorder. With no load on the belt, the beam upon the end of which is mounted the cell, light and condenser lenses causes the focused point of light to be just below the bottom of No. 1 slot, which means that no impulses will result as the chopper is rotated. When the beam is raised in proportion to the load on the short arm of the beam, the proper number of impulses will be obtained proportional to the load, from zero to the capacity at which the scale is calibrated. At full load 32 contacts per revolution are obtained. With 350 contacts per minute and conveyor belt speed of 350 feet per minute an impulse is obtained for each foot of belt, representative of a certain amount of material passing over scale.

Balancing the scale is a simple operation. A weight is provided which when hung on the

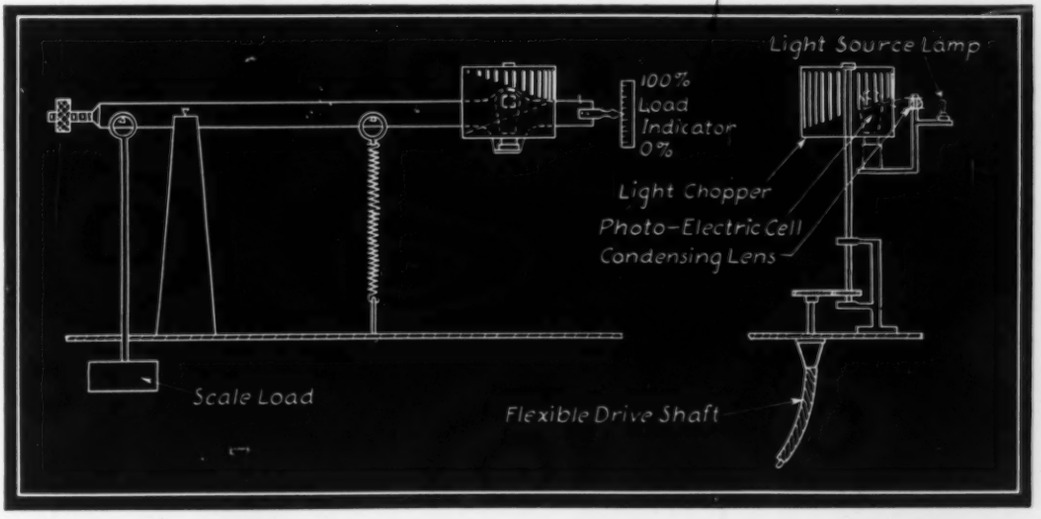
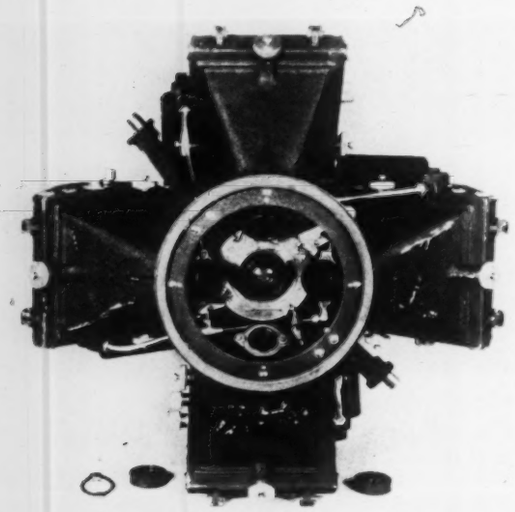


Fig. 1 — Diagram of conveyor scale showing the arrangement of the photoelectric cell and light source, the ray of which is intercepted by a light chopper to produce impulses for operating the driving unit of the register or recorder. The electric impulses are converted into units of weight

beam represents exactly half load. There is also a switch which when thrown cuts out the register and closes a circuit to a small lamp to flash it at each impulse. A change gear is installed which will slow up the revolutions so that the flashes may be counted. If the machine is in balance when starting up with no load on the belt, 16 contacts will be obtained. Should it be out of balance the balance ball is adjusted to cause 16 contacts to be obtained per revolution.

Engineers Look to the Camera

CAMERA study is finding an important place in technical undertakings and the slow motion picture has solved many an engineering problem. In conjunction with spark photography it is possible to take photographs of a rifle bullet every few inches as it leaves the muzzle of the gun. The rate of explosion of a stick of dynamite can be measured, showing the speed at which the explosion travels from one end of the stick to the other.



Wide World

Fig. 2—Five-lens aerial camera covers wide range and is indicative of new trend in photography

One of the latest developments in the field of photography is a new five lens aerial camera, Fig. 2, with which 3600 square miles of mapping was completed in two flying days. This work would have required a half year's effort with ordinary equipment. It was done for the department of the interior and was accomplished at one-thirteenth the cost allowed for such projects. The photography was completed in three hours.

This new camera has a central lens which "shoots" vertically and "wing" lenses at the sides taking obliques at different angles. A laboratory instrument is used to rectify distortion and a new film particularly sensitive to red and green light is used. The employment of this camera is significant of the trend in the use of photography to enable engineers and more recently designers of machinery to study opereration with a view toward development. In the discussion of a paper on the uses of movies in industry presented before the American Society of Mechanical Engineers, it was brought out that a manufacturer of milking machines uses a picture film to good advantage in increasing the efficiency of his machine and tool equipment. This is just one example of the practice, which holds broad opportunities for further refinement in design through close study of "screened" operation. The multiple-lens camera may reveal even greater possibilities.

Stainless Steel in Aircraft

FOR the first time in the history of aviation an airplane has been constructed from stainless steel. This is a new amphibian of the Savoia-Marchetti type slightly enlarged to accommodate four persons and powered with a 210-horsepower motor. It was built by the Edward G. Budd Mfg. Co., Philadelphia, and is a radical departure from conventional aircraft construction marking the culmination of three years of research with stainless steel for use in aircraft. The 18 per cent chromium and 8 per cent nickel type of alloy steel was employed.

Contemporaneously, Great Lakes Aircraft Corp., Cleveland, is working on a steam turbine type airplane engine, the development of which is being facilitated by the use of chrome nickel alloys to resist effectively high temperatures, pressures and corrosion (MACHINE DESIGN, Nov., 1931). According to the Budd company, stainless steel surpasses both duralumin and high tensile steels. The former, it declares, is subject to deterioration from corrosion and engine vibration while the latter is so thin as to be weakened severely by even the slightest corrosion.

Before stainless steel could be employed suc-

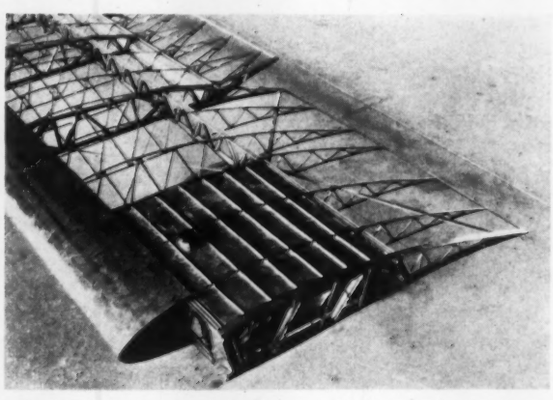


Fig. 3—Construction employed in wings of the first airplane built entirely of stainless steel

cessfully in the construction of this new plane a method of welding had to be devised by the builders. The new system has been termed "shot welding," and is adapted to the peculiar metallurgy of this material. The term is descriptive of the huge current values impressed explosively on a small area in an incredibly short time. Fig. 3 shows the type of construction employed in both the lower and upper wings.

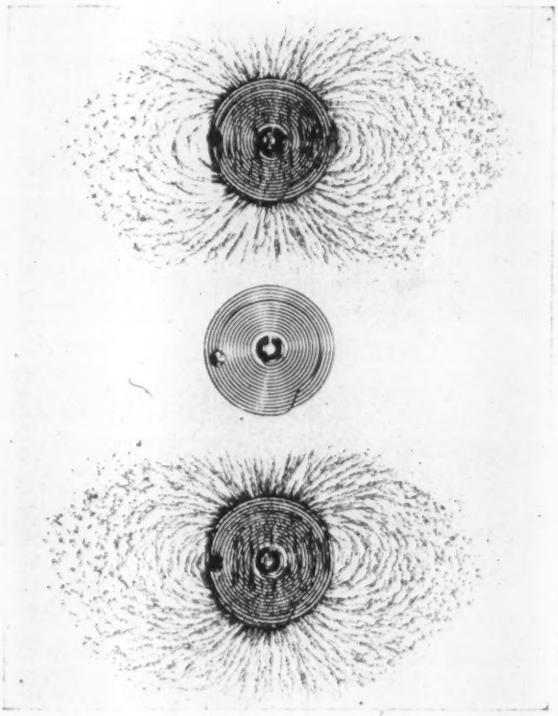


Fig. 4—Three hairsprings subjected to the same magnetic field. Elinvar spring is shown at center

Nickel Alloy Refines Design

MANY of those who have carried their watches around electrical apparatus have experienced the troubles caused by magnetism. Not only for the welfare of their timepieces but also from an engineering viewpoint will technical men designing machinery be interested in the recent use of a nickel steel alloy called elinvar for hairsprings. This material is incapable of being permanently magnetized.

Word comes also from the Hamilton Watch Co., Lancaster, Pa., that for the first time in the history of watchmaking the need for a temperature compensating device has been eliminated. This simplification of watch mechanism also has been made possible by elinvar. As its elasticity remains constant regardless of temperature variations, the new alloy, made up of nickel, iron, chromium, tungsten, carbon, manganese and silicon, brings to a hairspring the quality needed to assure uniformity of conduct under any temperature; and not only to watches but to every sort of precision instrument requiring a hairspring or a part that should be impervious to temperature variations.

Fig. 4 (top and bottom) shows a conventional hairspring and its attraction for steel filings. The elinvar spring is at the center of the illustration. All three parts have been subjected to the same magnetic field.

Vacuum Principle Is Utilized

VACUUM comes to the aid of the designer again, this time in the development of a suction crane to lift flat sheets of steel and nonmagnetic materials including nonferrous metals, paper, cardboard, fiber, wallboard, glass and lumber. Possible uses of the device are almost unlimited.

The crane, introduced by United Engineering & Foundry Co., Pittsburgh, is a self-contained unit consisting of a series of suction cups mounted on a bracket suspended from a boom or crane bridge, Fig. 5. Vacuum is created by a small motor-driven pump with air lines to the suction cups. The pump runs continuously and the vacuum is controlled by a two-way valve which either applies the vacuum or admits the air for release.

The suction crane first was designed to handle nonferrous slabs in connection with a casting machine. Later the unit was applied to lifting copper plates 40 feet long and ¼-inch thick from a pile to a roller table. It has handled zinc cakes weighing 300 pounds each, unloading them from freight cars. In a plate mill the crane has been operated in connection with a shear, replacing a caster bed. From this it will be seen that the need for a unit to replace the much-used magnetic crane which of course was unsuitable in some of the above instances, has been filled and that the vacuum principle has solved another design problem.

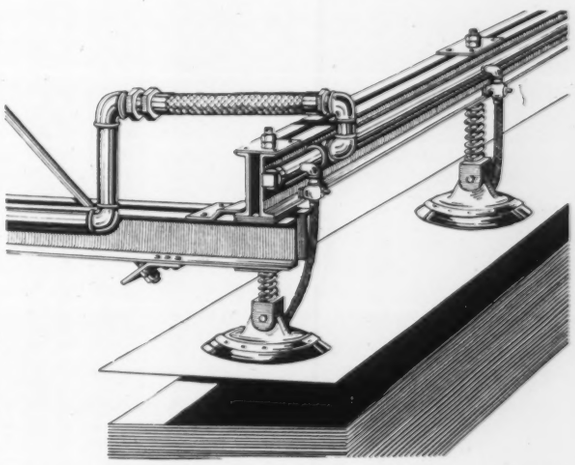


Fig. 5—Crane employs suction cups to lift flat sheets, particularly those of nonmagnetic or polished material

Design and Purchasing Should Go Hand-in-Hand

By L. E. Jermy
Managing Editor, Machine Design

UNDER ideal conditions the chief engineer and the purchasing agent in a company engaged in the manufacture of machinery should make a harmonious team. Their functions are both complimentary and supplementary. A concern whose design and purchasing chiefs understand each other and co-operate effectively has a decided advantage over competitors in whose organizations the relations between the two are not what they should be.

This is especially true in the present period when it is so important to incorporate in design every possible advantage that can be derived from intelligent purchasing. If there ever was a time when designer and purchaser sorely needed each others' good offices and assistance that time is now.

When a machine is being designed the chief engineer has a very definite idea of what is required in a certain part. But to him this idea may be expressed in terms of strength, rigidity, toughness, hardness, ductility or other physical properties. He will also possess a good working knowledge of the various materials available which embrace these desired properties. But in determining which of the materials can be obtained most advantageously, the purchasing agent's training and experience come into play.

It is at this point that the relations between the engineer and purchasing agent are given the acid test. If the former is too exacting in his specifications, if he refuses to give the purchasing head reasonable latitude, or if he fails to recognize the fact that considerations of price, economy, convenience in production, etc., should be weighed along with those of pure nicety of professional design—then there is bound to be misunderstanding and friction. Likewise an arbitrary stand on the part of the purchasing agent will cause trouble. If he pushes the matter of price to the point where it interferes seriously with real engineering requirements he makes it difficult for either side to arrive at the proper decision.

These differences may seem to be founded on petty considerations, but it should be remembered that engineers and purchasing agents do not employ the same measuring sticks in appraising a supplier of materials or parts. The professional man in charge of design may become attached to a certain company because it has helped him solve a difficult problem or because its product appeals to him strongly. At the same time this company may be anathema to the purchasing agent because of offenses it has committed in deliveries, price policy, damage claims, etc. When this situation exists it is not surprising that the engineer and purchaser find difficulty in reconciling their divergent opinions.

The matter of authority sometimes is responsible for misunderstanding. In large manufacturing concerns where the design and purchasing departments are extensive enough to permit organization along definite lines

BETTER co-operation between those charged with design and purchasing can be stimulated by a study of the problems of each. MACHINE DESIGN has asked a number of purchasing agents to express their views on common faults which they notice in their dealings with design engineers. Their comments have been incorporated in the accompanying composite letter.

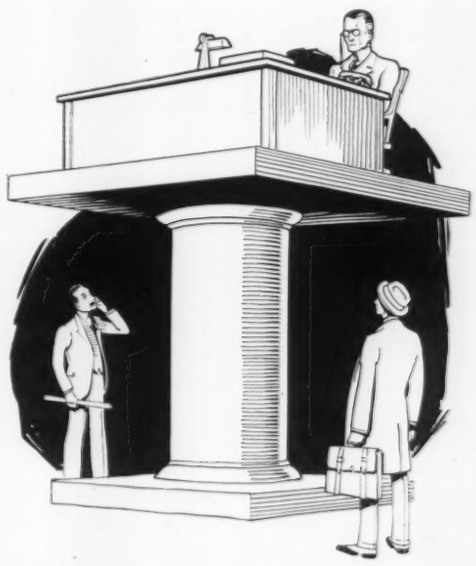
Next month design engineers will be asked to state the shortcomings of purchasing agents. It is expected that as in the past this exchange of frank comments will assist in bringing into the open the differences of opinion which usually are the basis for misunderstanding.

—The Editors

the duties of both are clearly defined and the chance for confusion due to overlapping authority is slight. Of course there are exceptions to this statement, but generally the engineering and purchasing in large corporations require such specialization that the seats of authority are too well established for petty dispute.

Confusion is more likely to arise in concerns of moderate or small size where the lines of demarcation between the prerogatives of designing and purchasing are not always clearly drawn. Here the degree to which the chief engineer restricts his activities to design and the purchasing agent to purchasing depends somewhat on the characteristics of these two officials.

A design engineer may be encouraged by opportunity or forced through necessity not only to specify what he wants but also to exercise all of the functions of purchasing except perhaps the actual placing of the order. Again the engineer may stop short at giving a general idea of what he wants and trust everything else to the purchasing agent. The division of functions may depend upon tradition in the company, relative authority of the engineer and purchasing agent, or their relative ability. In any event the result of their joint efforts is what counts. Good design can suffer tremendously if it is not backed up by intelligent selection and purchase of materials and parts. On the other hand the best purchasing agent in the world cannot offset the deficiencies of poor design.



"No engineer should set himself on a pedestal and be deaf to suggestions"

Readers of the accompanying composite letter will be struck with the similarity of the complaints made by purchasing officials with those voiced by salesmen, management executives and others in earlier articles in this series. The chief point of attack is the tendency among certain engineers to place factors of pure academic design ahead of economy, production convenience and other practical considerations. It is almost identically the charge made by the management that some engineers lack the "commercial instinct."

Another complaint—which probably applies to a relatively few chief engineers—is that exalted pride of profession causes them to assume an unbending attitude toward suggestions from those who would change specifications to a material or part which is cheaper, more readily available or capable of less expensive machining or assembling costs but which is equally good from the standpoint of mechanical fitness or serviceability. Here again the complaint is similar to those advanced by other critics who expressed themselves earlier in this series.

What We Think of the Engineer

—By a Group of Purchasing Agents

IF THERE is any one weakness among engineers which comes to the attention of purchasing agents more frequently than others it is their failure to determine in advance the ultimate cost of an article to be purchased or manufactured. Even this would be excusable if the design engineer would make inquiry of the purchasing department in time to do some good. In too many cases, however, the designer does not inform anyone of what materials or parts he will require for a new machine until the plans are in an advanced stage. Then the entire organization has a frantic time trying to find something that will make the best of a bad situation.

Who has not met the engineer who fails to consider the manufacturing viewpoint of a cast iron lever or bracket as to whether it should be routed to the milling machine or to the Blanchard or Pratt & Whitney type of surface grinder; or specifying or investigating the possibilities of a die casting if the part is to be used in sufficient quantities to warrant the investment in necessary equipment? Will he consider the use of a punch press product instead of a screw machine job; or whether the use of materials now purchased and stocked in large quantities will serve as well and as economically as the "first size stock" that he thinks of or the nearest size that "fits?" Does he ascertain if the part can be purchased cheaper than his company can produce it or specify brass when steel will serve as well or vice versa? He seems to follow the lines of least resistance in order to get the job "off the board."

We have found many design engineers who specify "tolerances" that are costly to produce and are unnecessary to the ultimate satisfactory operation of the machine—

tolerances so close in some instances that a large investment is necessary in jigs, fixtures, gages and necessary tools for the inspector. Again they specify tolerances on wood products that cannot under any consideration be produced and maintained due to the nature of the material.

Designers sometimes are found guilty of virtually forcing their employers to pay out good money unnecessarily for the sole purpose of upholding their (the designers') reputation. This usually happens when the engineer has encountered difficulty with a certain part or material. If it has failed at some time in the past the engineer feels duty bound to make sure a repetition does not occur and more often than not he redesigns it with a factor of safety far in excess of what is reasonabe. If this unrequired excess of strength persists in the specifications for a number of years the company pays a pretty penny for making doubly sure its product is right—or for upholding the reputation of its engineering staff. If anyone doubts that this situation exists, let him compare typical parts on models of machines made by different companies. He will find connecting rods, piston pins, shafts, etc., differing in cost as much as $30 per ton of steel but doing exactly the same work under identical conditions.

Not all engineers welcome suggestions from other departments. Some of them seem to feel because a recommendation originates from us that the only motive is the substitution of something "cheaper." They lose sight of the fact that the purchasing agent is just as much concerned as the designer himself in improving the company's product as to appearance and efficient operation in addition to the manufacturing cost. Often, too, they will insist that the blueprints be followed to the letter and sometimes will arrogantly resist the efforts of the purchasing department to modify the specifications.

Savings Would Wipe Out Charges

In an instance of this kind the engineer called for the use of iron rivets on a small assembly. The purchasing department suggested that drive screws be used instead of rivets but the design had gone too far for change at that time. Later the purchasing department had an opportunity to ascertain the cost of drive screws on a similar assembly. Even with an expense of $50 for changing over the drill jig, the savings resulting from the use of drive screws would wipe out this charge in six months. This expense could have been avoided and in addition a lower assembly cost could have been achieved at the outset if the engineer had invited the purchasing agent to sit in on the problem when the assembly was "on the board."

The tendency on the part of some engineers to hold obstinately to their own ideas in the face of suggestions from others often makes it difficult if not impossible to maintain a spirit of co-operation between the design and purchasing departments. No engineer—no matter how good he may be—should set himself up on a pedestal believing that his "mind" as he has expressed it on blueprints is beyond the stage where the lowly purchasing agent dares to offer a suggestion that is worthy of consideration.

It is usually assumed that a good engineering department keeps well informed on new developments in parts, materials and methods, but many purchasing agents know from experience that this is not always true. The number of blueprints which come out of the design department calling for parts that have been discontinued or involving methods that have been superseded is evidence of lack of familiarity with progress in the field or of failure on the part of the design department to keep its files up to date.

Whether both design and purchasing departments should keep complete separate files of catalogs is a question that must be decided in accordance with the requirements of each individual company. However, the purchasing agent usually finds it absolutely necessary to maintain his file carefully up-to-date. If the engineer does not think it necessary to do likewise or if he is willing to rely on the purchasing agent's data then he should consult the latter before blindly incorporating a detail into the working drawings.

In recent issues of MACHINE DESIGN engineers and salesmen of materials and parts discussed problems involved in their relations, and frequently mentioned the purchasing agent.

Most purchasing departments consider it highly desirable to keep in touch with new developments through the medium of salesmen. On standard items the purchasing staff and the salesman usually can give the matter all the attention that is required but on materials or parts involving decisions requiring engineering judgment the advice of the design department is important. For this reason the average purchasing official tries to shunt certain of his salesmen callers to the chief engineer or his assistants.

Strange as it may seem the engineers who display the

"Insists that specifications be followed to the letter"

greatest lack of knowledge of new developments are those who complain most bitterly of the purchasing agent's alleged practice of "directing salesmen to the engineering department when they could have been handled just as well by the purchasing staff." In many cases the chief engineer who frequently says to the purchasing agent, "You talk to him (meaning a salesman); I'm terribly busy," is the one who often is in hot water because he doesn't know what is going on in the world beyond the door of his own department.

Of course all purchasing agents are not perfect. Elbert Hubbard even went so far as to say:

"The typical buyer is a man past middle life, spare, wrinkled, intelligent, cold, passive, noncommittal; with eyes like a codfish, polite in contact, but at the same time unresponsive, cool, calm and as damnably composed as a concrete post or a plaster-of-paris cast; a human petrification with a heart of feldspar and without charm or the friendly germ, minus bowels, passions, or a sense of humor. Happily they never reproduce and all of them finally go to hell."

All of which makes one feel that perhaps sometime in his life Mr. Hubbard may or may not have had an inclination to design machinery. Perhaps, too, some engineers feel today toward purchasing agents as Elbert Hubbard has expressed himself.

Fig. 1—Various types of cartridge heaters which are especially suitable for producing high heat at one point

Applying Electric Heat to Machines

By Allen F. Clark
Editorial Representative, Machine Design

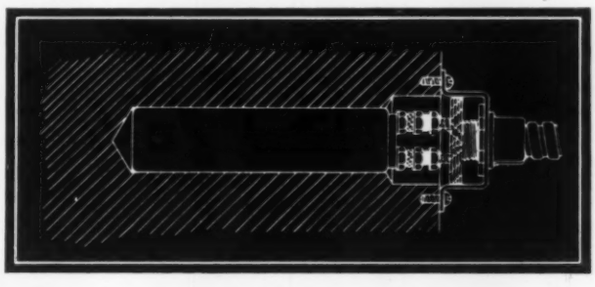


Fig. 2—A drilled hole that has been countersunk to provide clearance for bolt terminals is used in installation

HEAT, properly applied, has an important place in the operation of many machines, yet too often the selection of type of heat and method of application is treated as merely a secondary consideration in the design. The application of heat not only alters and improves the articles being fabricated or manufactured, but usually this induced change is the determining factor in establishing the quality of the completed manufacture. Correct application of heat is essential to high quality and yet it often happens that a machine is designed completely before the question of heating units is decided.

Modern design is turning to the use of electric heating equipment which has been developed to cover practically the entire field of industrial heating. Use of these units in machinery demands that it be confined to a localized area that requires the higher temperature. In fact, one of the outstanding merits of electric heat lies in the possibility of easily and safely confining it to the point of application, thereby eliminating contamination of atmosphere, excessive room temperature, danger to operators, products and equipment. Operating economy and precise temperature control when uniformity of temperature is essential to the process are also results of careful planning of the location of the source of heat energy.

Heat Must Be Easily Distributed

There is, however, an important requirement in the application of units that is in seeming disagreement with the principle of heat localization. Any amount of heat may be supplied by the units, but in order to obviate the possibility of burning them out, there must be provided means for dissipating the heat developed. This does not mean dissipation of the heat to parts of the machine not to be heated or to the room. The heat developed must be removed from the area adjacent to the unit and be distributed evenly throughout the substance to be heated.

A simple example will clarify this point. If a unit is used in a casting, the size of this unit must not be so large that it will generate more heat than the metal will conduct away. Also, if a unit is designed for use in a liquid, exposure to air with its lesser powers of conduction will burn out the unit as the heat generated will not be conducted away at the proper rate. It can be said that practically all heater burnouts are due to excessive heater temperature caused

by obstruction of the flow of heat away from the source, or excessive wattage rating.

Radiation losses and the facility of insulating against them should be given every consideration in designing the shape and contour of the part to be heated. The most important factor in heat loss is the gradient between the temperature of the heated part and the temperature of the surrounding air; the higher the temperature difference the greater the necessity for insulation. Every part that is exposed to surrounding air loses heat by direct radiation and convection through air currents. Therefore, the exposed uninsulated area should be kept at a minimum, particularly when the operating temperature is relatively high.

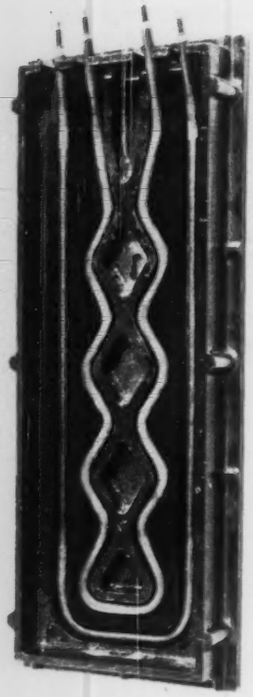


Fig. 3 — (Left) — Sheath wire heaters ingeniously arranged to provide uniform heating over a flat surface

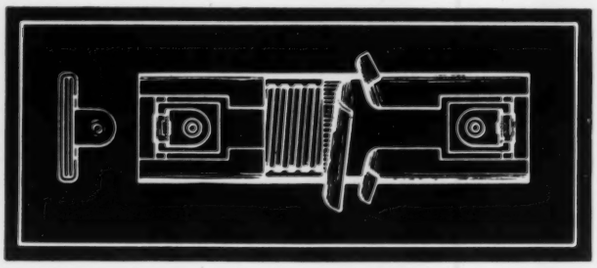


Fig. 4—Construction details of a strip heater for conduction applications showing heating wire case and insulation

Calculations of heat requirements generally must take into consideration the following:

1. The thermal capacity of the entire mass of material being heated. This is particularly important in determining initial heating up time
2. Heat taken away by the work passing through the machine
3. Heat used for conduction, radiation, and air convection, and losses

Extra Units May Be Required

Sometimes the heat requirements for bringing the temperature up to the operating temperature necessitates installation of extra heaters; this is particularly true when the time permissible for heating is important. When the machine heats a product as in a bread wrapping machine, or when a material is immersed in a hot liquid, the material absorbs heat that is dissipated and lost when the material passes through the machine. This must be taken into account in determining total heating requirements. The initial and final temperature of the material must be known, as well as the nature of the material, its weight and the rate at which it passes out of the machine.

The amount of heat required to maintain the proper temperature may be dependent upon so many varied conditions that it is extremely difficult to calculate power requirements. In such cases it is best to experiment with units of various ratings until the proper size has been determined.

Close Calculations Are Necessary

When experimentation is impractical the designer must calculate as closely as possible the total wattage requirements and determine the size of available heaters suitable for the application. A remarkably accurate estimate of heating requirements and recommendations on design of the part to be heated may be made from available tables of heat absorbing capacity, specific gravity and other characteristics of materials.

There should be a thorough appreciation of the fact that the application of electric heaters necessitates a most accurate determination of wattage requirements. The difficulties resulting from the application of insufficient heaters is obvious; application of too many heaters penalizes the salability of the machine.

Before attempting design of the heated part a thorough knowledge of the types of units available and the most suitable applications of each is advisable. There are three main types of metallic heating units although each of these types has subdivisions. The principal types are: Sheath wire, which resembles a metallic rod having a terminal on each end for electric connections; cartridge, which generally is similar in construction to the sheath wire type except that the resistor coil is not self-supporting and both terminals come out of the same end; and strip, which is a metal encased heater resembling a piece of flat strap iron.

There is an important type of nonmetallic heating element which is manufactured in cylindrical rods of Carborundum brand silicon carbide. This unit has its application in the heating of air in furnaces and other closed areas.

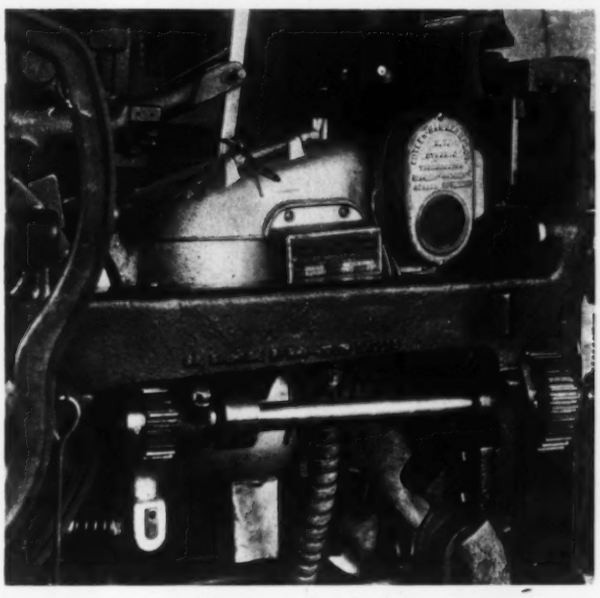
The principal variation of the general types is the immersion type which may be a sheath wire

unit suitably encased and bent to form a complete circuit, or a cartridge unit encased in a good heat conductor and arranged for immersion. Strip heaters are manufactured for three general purposes, the transfer of heat by conduction, by convection in baking ovens or in rooms, the units used for this purpose being known as space heaters, and as resistance units.

Although it is not practical to state that any one type of unit is the best suited for a particular job, in general, cartridge type units are used for the heating of a mass of material, such as a casting, while strip heaters are used for heating thinner sections. All of the units can be used for any type of job. The selection of unit does not depend upon the type of work to be done, but depends wholly upon the available means of mounting the unit, what portions of the machine must be heated, degree of localization etc.

Cartridge type units, Fig. 1, are ideal for applications where heat must be concentrated and the temperature required is low. They are best applied by inserting in a slightly oversize hole in the part to be heated. The unit swells in service until it fits the hole tightly. This gives excellent thermal contact and insures efficient transfer of heat as well as long life for the unit.

Fig. 5—(Below)—Linotype pot which employs several types of electric heating units. Fig. 6—(Right)—Cross section of pot. A is the mouth heater, B the throat heater, C and E the outer and inner crucible heaters and E the thermometer bulb for regulating temperature

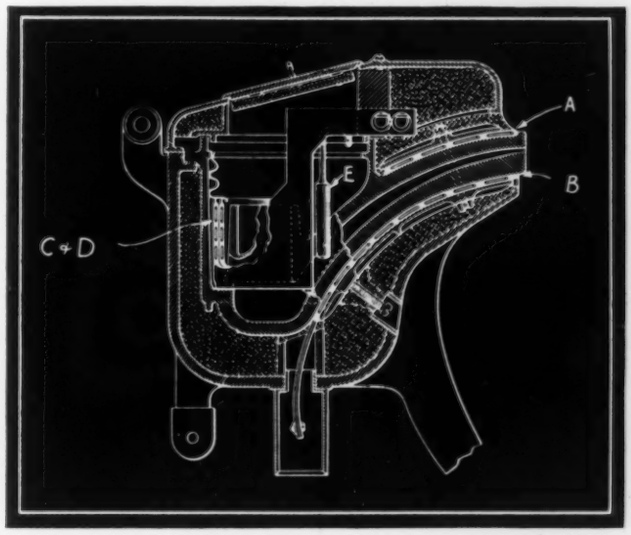


In applying the unit, it should be placed as close as possible to the point where heat is required, and in proper relation to it. For standard units a temperature of 750 degrees Fahr., is practical.

These units also can be built in hollow types through which the product of the machine may be passed. The solid types have been manufactured ⅜ to 3½ inches diameter, from 1½ to 31 inches long, rating from 50 to 8000 watts.

Sheath wire is the most adaptable of the units. It can be used in almost any low temperature application while maximum advisable temperature is about 1000 degrees Fahr. These units can be constructed with any type of sheath, bent into any shape, Fig. 3, formed as an integral part of castings, and used with almost infinite variations. The units are bent and formed in much the same manner as an annealed rod of the same dimensions. Innumerable applications can be satisfied correctly by varying the material in the sheath. Approximate size limits are from 6 to 150 inches long. They have been built to carry as low as 50 and as high as 10,000 watts.

Limited by the fact that it can be applied only to relatively flat surfaces, the strip unit, Fig. 4, still finds innumerable applications. It also can be properly incased and formed into castings. It



can be bent on long radii, and can be formed around the side of pots. Fig. 6 shows these units applied along the throat of a linotype pot and bent around the pot to heat the interior.

Correct Clamping Is Important

In conduction applications, correct clamping to the machine part is of utmost importance. The surface against which the unit is to be clamped should be smooth and clean. If the machine part is a casting, it is desirable, and in some cases essential, that the casting be machined. The heater should be clamped to give a firm and complete contact so as to facilitate the flow of heat to the parts thus preventing excessive temperature in the heater. Care must be taken as unequal expansion of clamp and heater may cause distortion and defeat the purpose of the clamps. Welded on conduction heaters can be supplied.

Conduction heaters, Fig. 8, generally are flat strips approximately 1½ inches wide by 24 inches long rated at 500 watts. They are provided, however, in sizes from ¾ to 3½ inches wide, 4

to 48 inches in length, and with ratings from 75 to 2300 watts. The 500-watt rating is generally suitable for temperatures up to 750 degrees Fahr., but there are many conditions under which the ratings per square inch must be lower and just as many where they must be higher. Strip units may be obtained with two or three terminals, all at one end or one on each end, giving from one to three variations in the

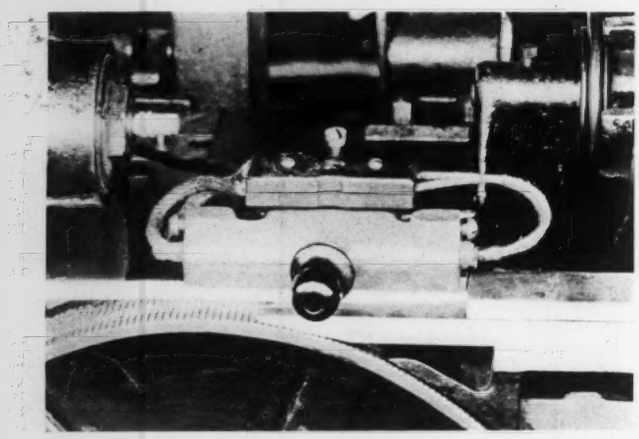


Fig. 7—Electrically heated sealer in contact with cigarette rod on cigarette machine. The rod, shown at the left, is the paper tube filled with tobacco

amount of heat. They are also formed into ring units which, carefully applied, are suitable for use on the bottoms of metal or liquid pots.

The number of heating units used and the method of their arrangement depends solely upon the area to be heated. All units are rated in watts per square inch of heating surface. They may be arranged to give one or more heat variations in each unit, mounted in parallel or in series, encased in many different materials, in short there is no limiting factor on the amount of heat obtainable. And, furthermore, there is no restriction from the heating units available as to how this must be applied, or the number of steps available. With a parallel hook-up further gradations in amount of heat may be obtained. There are also available manual and automatic rheostats and thermostats that can be used to control the heat input.

Units Rated Close to Maximum

Applications using heating units necessitate a more accurate consideration of actual voltage values than contactor and motor applications, as heaters usually are rated close to their maximum safe limit in the interests of economy. Since current through a unit varies directly as the voltage and since wattage varies as the square of the current it is obvious that even a slight increase in voltage over the rating will result in a considerable increase in wattage. Where conditions necessitate rating heaters extremely close to the maximum limits it is customary to permit a voltage variation of only five volts over rated voltage. However, standard heaters can withstand greater variations. It is obviously desirable to provide an installation that will permit a relatively great voltage variation provided the functions to be performed by the machine permit it.

Terminals must be covered, or units so located as to minimize the possibility of the operator contacting with live parts, and the heater itself must be protected against mechanical damage. Every precaution should be taken to avoid accumulation of refuse on the heater, particularly at the terminals. A method of mounting which protects the terminals is shown in Fig. 2.

Many materials such as oil and paraffin have an extraordinary tendency to creep and if permitted to accumulate at the terminals they will enter and slowly, but unfailingly, cause deterioration of insulations and ultimately result in destruction of the unit. Alternate expansion and contraction of heaters due to temperature changes causes a sort of breathing action which tends to draw in any accumulation at the terminals. It is conditions such as these, that make it advisable to design installations so that they may be inspected or replaced easily.

Each application involves its own, individual engineering problems, and usually consideration of characteristics of materials, so it is impossible

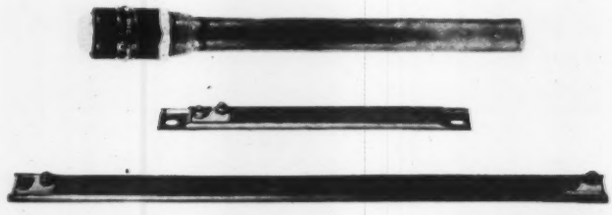


Fig. 8—Immersion unit (top) and strip heaters

in this limited space to establish rules or engineering data that can positively assure success of any heating application. However, the essential facts governing electric heating of machines and machine parts, as related in the foregoing, should facilitate intelligent consideration of the subject and permit compilation of a specification for any problem from which the heating engineer, with his wealth of information on heaters, materials, and actual installations can make a complete recommendation.

For assistance in preparing the subject matter in this article, and for the illustrations presented, MACHINE DESIGN acknowledges the considerate co-operation of: Cutler-Hammer, Inc., Milwaukee; General Electric Co., Schenectady, N. Y.; Edwin L. Wiegand Co., Pittsburgh; Harold E. Trent Co., Philadelphia; Watlow Electric Mfg. Co., St. Louis; and Globar Corp., Niagara Falls, N. Y.

Developing Combined Translatory and Rotary Motion

By William A. Rosenberger,
Consulting Engineer, Hagerstown, Md.

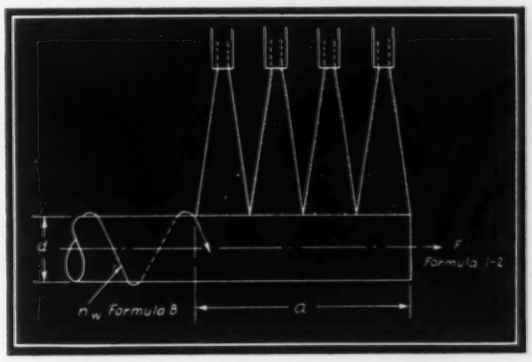


Fig. 1—Typical situation in which rotation and translation of object piece is required

SIMULTANEOUS feeding and revolution of cylindrical work is a problem in combined translatory and rotary motion that often must be overcome. Typical examples of this situation are found in the welding of spiral pipe, in machines designed for cleaning the outside of locomotive boiler flues, in continuous grinders for round bar stock, in equipment for uniformly sand blasting outer surfaces, and in similar mechanisms.

Developing formulas particularly for sand blasting, flue cleaners and grinders, the typical situation shown in Fig. 1 is encountered, where

d = Diameter of work, inches
a = Effective width of blast stream or tool, inches
F = Axial velocity (feed) of work, feet per minute

A simple reflection will show that to each revolution of the work the translatory (axial) motion must not exceed the distance a. In the case of scale removing machines (flue cleaners) and continuous grinders, the translatory motion should be slightly less, say 0.9 to $0.95 \times a$ in order to assure a complete overlap of the cleaned surfaces. In the case of sand blast machines no allowance need be made for overlap since the abrasive, as it hits the work, scatters sufficiently to take care of this.

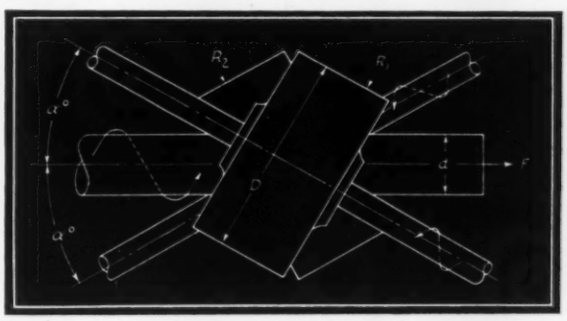


Fig. 2—The simplest method of obtaining combined translatory and rotary motion is by means of the principle of offset rollers

It is found, therefore, for grinders and flue cleaners

$$F = \frac{a}{12}\, n_w\ 0.90 \text{ feet per minute} \quad \ldots\ldots (1)$$

and for sand blast machines

$$F = \frac{a}{12}\, n_w \text{ feet per minute} \quad \ldots\ldots (2)$$

where N_w represents the revolutions per minute of the work.

The simplest method of obtaining combined translatory and rotary motion is by means of offset rollers, in principle as shown in Fig. 2. However, if flat faced rollers or wheels are used, there must be employed, in order to avoid stationary or semistationary work, guides which would introduce undesirable frictional resistances. If the angle α is not too small, two concave rollers, as shown in Fig. 3, may be resorted to as they automatically will guide the work in a straight line.

For the purpose of developing the theory of this drive, the rollers are assumed to be straight faced as the formulas thus found are applicable irrespective of the shape of the rollers. It is further assumed that only one of the rollers, say the top roller R_1, is driving, because the angularity α, speed of the rollers, and speed of the work is not affected if the other roller R_2 (or several other ones) are assumed to be idlers.

Suppose the drive roller R_1 could roll freely

in the direction from A to B, then, after one complete revolution, the distance AB would equal the circumference of the roller, Fig. 4, or

$$AB = nD \text{ inches} = \frac{\pi}{12} D \text{ feet}$$

The component of this motion, in the direction

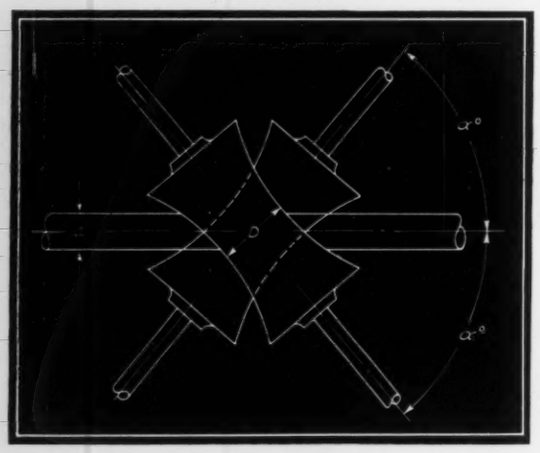


Fig. 3—Concave rollers will guide the work in a straight line automatically

of the work travel EF, is AC and evidently

$$AC = AB \times \cos (90 - \alpha) = AB \times \sin \alpha$$

If roller R_1 makes n_R revolutions per minute and were free to travel as before, its center would reach a point G and

$$AG = \pi D n_R \text{ inches} = \frac{\pi}{12} D n_R \text{ feet}$$

The component of this travel in the direction EF is

$$S = \frac{\pi}{12} D n_R \sin \alpha \text{ feet per minute} \quad \ldots\ldots (3)$$

which also equals the velocity F in the direction EF.

From equation (3) it is found that

$$n_R = \frac{12 \times S}{\pi D \sin \alpha} \quad \ldots\ldots (4)$$

Now, if roller R_1 be prevented in its translatory motion AG, the work piece will travel in its place and, of course, exactly the same distance

$$AG \times \sin \alpha = S = F$$

Therefore, for grinders and flue cleaners

$$\frac{\pi}{12} D n_R \sin \alpha = \frac{a}{12} n_w \times 0.90$$

or,

$$\sin \alpha = 0.286 \frac{a}{D} \times \frac{n_w}{n_R} \quad \ldots\ldots (5)$$

and, similarly, for sand blast equipment

$$\sin \alpha = 0.318 \frac{a}{D} \times \frac{n_w}{n_R} \quad \ldots\ldots (6)$$

or,

$$\frac{n_w}{n_R} = \frac{D \sin \alpha}{0.318\ a} \quad \ldots\ldots (7)$$

Assuming a and D to be known, there are still three unknown quantities in equations (5) and (6); two of which may be eliminated through a study of the rotary motion.

The revolutions per minute of the work which has been designated previously as n_w, may be determined from

$$n_w = n_R \frac{D}{d} \cos \alpha = \frac{12S}{a} \quad \ldots\ldots (8)$$

from which

$$\frac{n_w}{n_R} = \frac{D}{a} \cos \alpha \quad \ldots\ldots (9)$$

Substituting this latter quotient in equations (5) and (6) and dividing both sides of these

Fig. 4—Rollers which are assumed to be straight faced are used in the development of formulas which are found applicable irrespective of roller shape

equations by cos α, it is developed that for grinders and flue cleaners

$$\tan \alpha = 0.286 \frac{a}{d} \quad \ldots\ldots (10)$$

and for sand blast equipment

$$\tan \alpha = 0.318 \frac{a}{d} \quad \ldots\ldots (11)$$

For all, excepting sand blast equipment, a represents the effective width of the tool, i. e., that part of the tool which is in actual contact with the work.

In the case of sand blast equipment a depends upon the size and number of nozzles, the distance between nozzle and work, the kind and size of abrasive used, the air pressure and the angle of the abrasive stream against the surface of the work and finally upon the thoroughness and uniformity of blasting that may be required.

Motor Development Keeps Pace with Industry's Needs

By H. N. Blackmon

WITH the present-day trend toward increase in operating speeds and speed variation in machines, engineers responsible for design necessarily must keep posted on the latest developments in electric motor characteristics. How these are changing, and how the new motors are being applied, is related herewith by Mr. Blackmon, general engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOTORS especially adapted in character to do special jobs, sometimes being built even contrary to what formerly was regarded as their inherent nature, are the direct result of the demands of industry. Many, for example the planer motor with 10:1 speed range, have new electrical characteristics; others, like the first vertical main roll motor for steel mills, introduced radical mechanical combinations; and still others, such as the motor which gets the last ounce of power from the box-like niche of a coal cutting machine or the gasoline pump motor that resists explosions and can run at 40 degrees below zero, demonstrate modern engineering skill as it is employed to give industry the type of motor required for the specific job.

Increasing desire to mine thin coal veins, without the expense of removing rock, led to the design of a most extraordinary direct current motor for a coal cutter, Fig. 1. Totally enclosed and explosion proof, 50 horsepower at 1600 revolutions per minute is packed into this unit measuring but 12 inches high by 27 inches wide and 33 inches long. Despite the restricted space, the motor has four main poles (2 are consequent) and four interpoles. It is the highest power totally enclosed motor ever built for such service.

Chemical plants offer more hazards to motor operation than most other industries. This is particularly true in nitrate plants since the windings of the motor soon become covered with nitrate dust. When the motor is shut down at night, condensed moisture forms nitric acid that eats away the insulation. Recently shipped to the Anglo Chilean Nitrate Corp. were eight 250 horsepower synchronous motors, for driving crushers, which are impervious to nitrate dust. Vulnerable parts of the motors are metal-clad and a slight static pressure on the inside keeps the harmful dust from leaking in. Odd appearing, inclined fins on the metal enclosure throw off heat and guide the cooling air along the most efficient route.

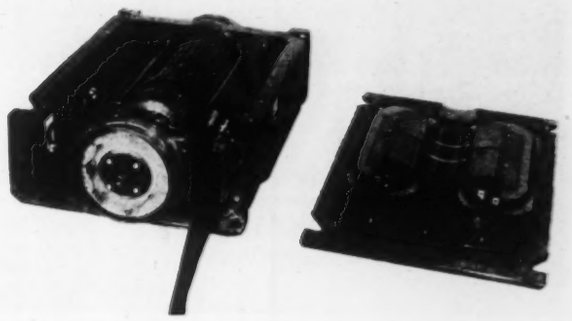


Fig. 1—By extremely efficient design 50 horsepower is developed in this small box-like motor

Double Ordinary Values

Besides protecting themselves from nitrate dust, these synchronous motors produce 120 per cent starting and 100 per cent pull-in torque—more than twice ordinary values. Rated at 90 per cent leading power factor they correct power factor as well as carry full mechanical load. Each rates 250 horsepower 550 volts, 450 revolutions per minute 60 cycle, 90 per cent leading power factor with 55 degree Cent. rise, at 5000 feet above sea level.

An unusual reversal of synchronous motor design is found in two of the eight motor-generator sets for driving elevators in the new Gulf building, Pittsburgh. Synchronous motors were wanted to correct power factor, and for the sake of quietness the two synchronous motors were

built with revolving armature, instead of the usual revolving salient fields. Coil ends on the armature serve as a fan and strategic baffles utilize the cooling air to best advantage.

Until five years ago 4:1 was a wide speed range for constant voltage direct current motors. For three years 6:1 has been the limit. This limit now is practically doubled.

The first two such commercial motors were completed recently. One is a 75 horsepower 250 to 1600 revolutions per minute motor. The second motor, rating 100 horsepower at 1500 revolutions per minute, has a 10:1 speed range (150 to 1500 revolutions per minute).

Powers Mill Without Gears

Entirely different is the motor recently developed which will power a vertical boring mill without gears. An ordinary boring mill often leaves objectionable "tooth marks" when turning delicate work like a commutator. There will be no gears on the machine to be built; the end of the armature will be the table and the motor frame will form part of the boring mill. Skewed slots will give exceedingly smooth torque. Equipped with variable voltage control it will run up to 180 revolutions per minute; at 92 R. P. M. it will deliver more than 100 horsepower.

Steel is another industry which recently has replaced gears by motors—the "twin-motor" electric drive, Fig. 2. The upper and lower main rolls of rolling mills previously have been connected together mechanically. Ignoring precedent Illinois Steel Co. is using an individual motor on each main roll with no mechanical connection whatever. The motor for each roll on the 54-inch reversing blooming mill rates 5000 horsepower, 40/80 revolutions per minute 700 volts direct current. Advantages include elimination of the gear set with its costly maintenance and lubrication; less vibration and a more uniform product; less flywheel effect in the rolls; and a simpler machine.

The installation is noteworthy in that 10,000 horsepower is 25 per cent more power than has been used before by a single stand mill, and it is the first installation using individual motor drive for rolling steel.

Another "first of its kind," steel mill motor is being used by Carnegie Steel Co. at its McDonald plant, Youngstown, O., to drive two main vertical stands in a new 10-inch bar mill. A vertical pass was chosen (rather than flopping the steel over, as is usual) when all passes are horizontal because the stands are close together and the steel travels extremely fast. The high horsepower required and small diameter of rolls prohibited a horizontal motor driving the vertical stands through bevel gears.

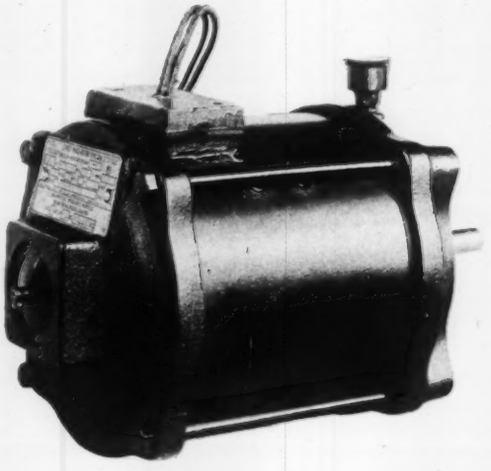


Fig. 3—A clutch-type motor for gasoline pumps that can withstand internal explosion and yet starts and carries full load at 72 degrees below freezing

The entire structure is mobile permitting the mill stand (housing, rolls, and motor) to be moved sideways so the various grooves in the vertical rolls match those in the horizontal rolls. Hydraulic pistons raise the mill up on its wheels for alignment; in position, it is lowered and automatically clamped fast.

Power requirements for cement manufacture center in the tube mill—a long revolving cylinder filled with steel balls which pulverize the raw material. Hitherto, these heavy mills driven by slow speed synchronous motors have been "clutched-in" (mechanically or electrically) after the motor has pulled itself into step under no load. The recent Simplex synchronous motor eliminates such makeshifts. Direct coupled, it accelerates itself and heavy load

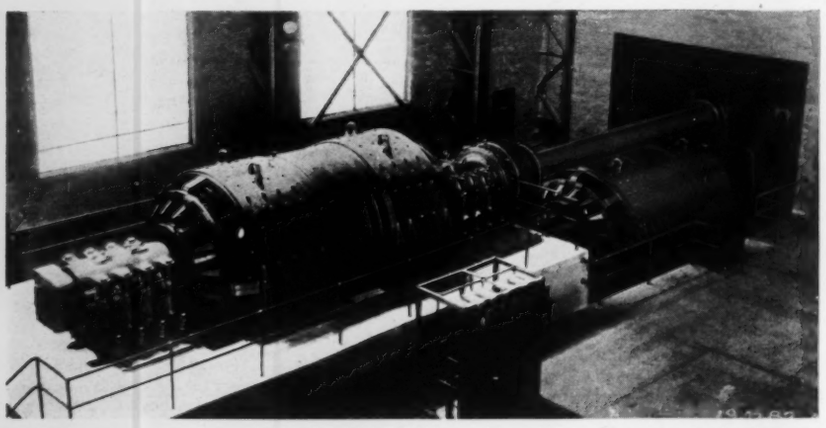


Fig. 2.—Individual 5000 horsepower motors drive the upper and lower rolls of new steel mill. All gearing is eliminated

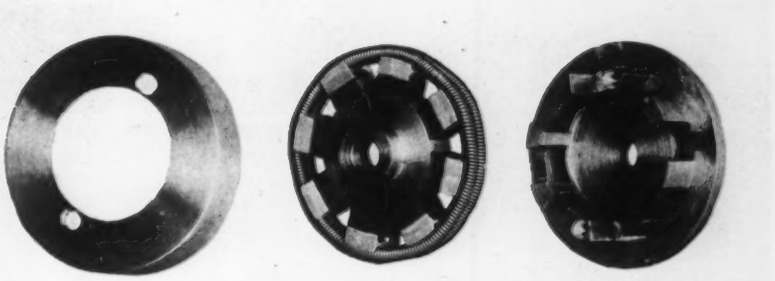


Fig. 4—Operating parts of the constant speed clutch designed for use on motors

with the ease of a wound rotor motor and then operates as an ordinary synchronous motor. Developing 150 per cent starting and 120 per cent pull-in torque with 250 per cent current inrush, it developed about three times the starting and pull-in torques obtained by ordinary synchronous motors having comparable starting current inrush. The secret of such performance lies in the polyphase damper winding, arranged very much like the windings on a wound rotor motor. Slip rings connect the polyphase damper winding to external control resistance which is reduced automatically during the starting period. Once in step, all the external resistance is reinserted in the damper winding circuit.

Ford Motor Co. recently installed four unusual multispeed synchronous motors for driving propeller type pumps (large volume, low head) at the River Rouge plant. Looking like small waterwheel generators, these vertical synchronous motors are designed for three-speed operation. Only two speeds are used at present, but when power requirements increase at River Rouge a separate stator and rotor will be slipped into the space provided for them in the present

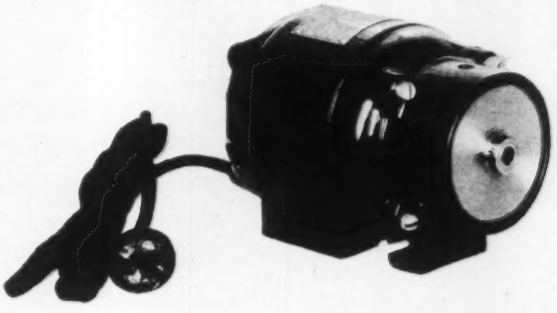


Fig. 5.—Coupling on the end of this series motor keeps a predetermined speed regardless of speed of motor

frame. The motors now rate 700 horsepower at 277 revolutions per minute and 350 horsepower at 138 revolutions per minute. Changing of electrical connections changes the speed. The future third speed is designed for 300 horsepower at 200 revolutions per minute. High pull-in torque, full voltage starting, automatic control and the ability of the motors to remain in step with 25 per cent voltage dip are other features.

Probably the most unusual blower motors built for some time are sixteen 1000 horsepower three-speed induction motors being built for the New York Hudson avenue power station. Best operational economy corresponded to speeds adjustable for 600, 900 and 1200 revolutions per minute. The stators each have two windings, the parallel or series connection of one winding giving 6 or 12 poles respectively and the second winding giving the 8 pole speed. Built for 2300 volts, these motors develop 200 horsepower at 600 revolutions per minute, 450 horsepower at 900, and 1000 horsepower at 1200 revolutions.

A whole flock of interesting little motors have emerged in response to the peculiar needs for driving washing machines, gasoline pumps, airplane generator, sign contactors, etc. Since washing machine motors run from ordinary house lighting circuits, on heavy loads they often would "blow" the 15 ampere lighting fuses. To overcome this worry, there was designed a motor which "jerks" when it encounters heavy load, Fig. 5, and then exerts a steady pull once the load is started—just as a workman does when trying to pull a heavy hand truck. An explosion proof clutch-type motor of this sort, Fig. 3, is used for driving gasoline pumps in arctic climates. Tested in "dry ice" (solid carbon dioxide) at 72 degrees below freezing it started promptly and clutched-in its load in 90 seconds.

Employ Garter Spring Clutch

After much research, electric regulators for universal motors were discarded for some applications in favor of a simple little garter spring clutch, Fig. 4, free from the aberrations for which friction devices are sometimes notorious. Its constant-speed performance is maintained substantially accurate over a wide range of driving speeds. As to permanency, it can transmit one horsepower at 2400 revolutions per minute, with 600 revolutions per minute slip, continuously for 700 hours. Aircraft designers have found it just the thing to drive auxiliary generators at constant speed from the main engine shaft, regardless of engine speed.

Fan motors are beginning to take on small power jobs such as driving furnace blowers, winding machines, or other applications where the so-called small motors would be too large or costly. They are equipped with attachable feet. Ratings range from 1/250 to 1/60 horsepower. The oscillating mechanism makes a convenient reduction gear drive.

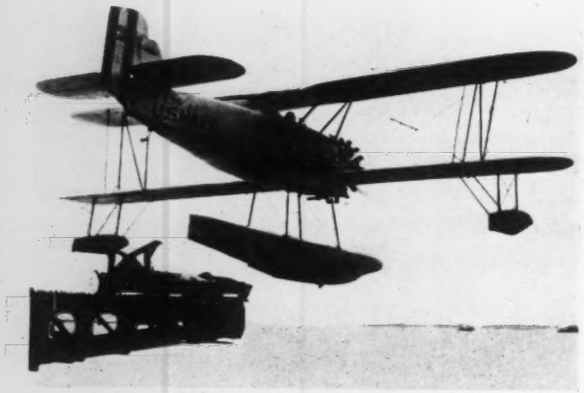


Fig. 1—Navy seaplane leaving catapult. The engine is brought up to maximum speed before the catapult is fired, and elevators are set for horizontal flight.

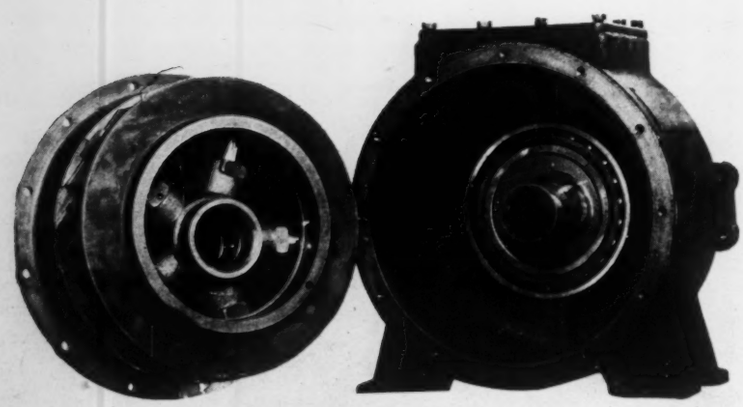
Electro-Hydraulic Navy Catapults

ANTICIPATED successful development of new products foreign to a manufacturer's established line often proves to be a delusion. Competition in fields with which the producer has had no experience or that of the most meager type easily can lead to unsatisfactory sales and consequent withdrawal from the market. A logical alternative exists, however, in the development of new applications and new markets for the manufacturer's established products.

Builders of electro-hydraulic power units made commendable progress in invading a new field when their engineers recommended the utilization of their equipment for operating auxiliary mechanisms of airplane catapults as used in launching planes from the decks of battleships. Previously this catapult machinery had been operated manually, pneumatically or electrically but not with such accurate regulation.

In naval operations, Fig. 1, it is essential that the planes be launched expeditiously and sometimes in rapid succession. To facilitate these desiderata the catapult has to be rotated on its turntable to the various required positions for loading and shooting. Loading consists of transfering the airplane from its stowage truck to the small launching carriage which is towed along the top of the catapult. Shooting is the action of pulling this loaded carriage along the greased tracks to accelerate the airplane to its flying speed. The launching carriage with its superimposed plane must be pulled back from the loading to the firing position and the empty carriage retracted after each shot. These operations require ample power, a considerable range of speed, maximum starting torque, instant stopping and reversing, and fine adjustments of control when the heavily loaded carriage is being eased up to the restraining mechanism. The machinery must stand extremes of weather and salt water, when exposed unprotected on the open deck, and still respond instantly to the throw of a switch.

These exacting requirements have been met by two types of electro-hydraulic power units, the basic features of which are that they trans-



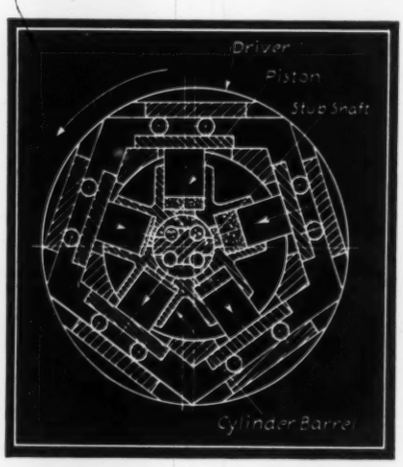


Fig. 2—(Left)—Internal view of Oilgear pump, one of the types used for controlling the power of the catapult. Fig. 3—(Above)—Diagram of the pump shown in Fig. 2

Equipment Controls

By Robert W. Cuthill

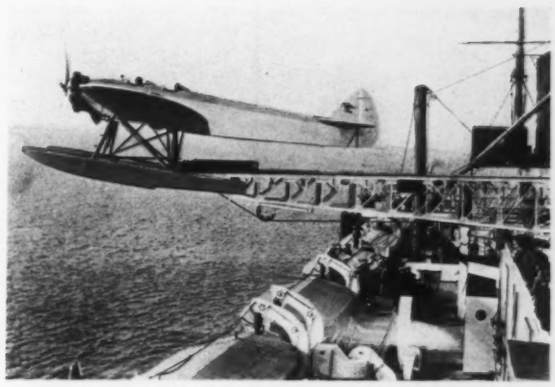


Fig. 4—German Heinkel catapult on the S. S. Bremen. One float is secured to the launching car and is released automatically when the car stops

INCREASING use of hydraulic equipment has brought to light numerous applications of special interest to the machine design field, particularly in connection with employment of electro-hydraulic units. Advantages of these are discussed in the accompanying timely article prepared by an authority on the subject of airplane catapult design. Mr. Cuthill is engineer in charge of this work at the Naval Aircraft factory, Philadelphia.

mit rotary power in either direction at infinitely and instantly variable speeds from zero to maximum while the source of power rotates continuously in one direction at uniform speed. This mechanism is not affected by extremes of weather temperature, the medium of hydraulic power transmission being special oil or good mineral oil. Oil also makes the mechanical parts self-lubricating and at maximum load the machine is approximately 95 per cent efficient. No damage can be done by overloading as safety valves automatically relieve the excess pressure. All operating parts are enclosed and complete control is effected by a push button switch for the electric motor and a single lever or handwheel, swinging a variable distance to either side of a neutral point, for the hydraulic pump.

Pistons Are Mounted Radially

The hydraulic units used for this application have pistons radial to the axis of rotation, Figs. 3 and 7, while a third similar unit which might be employed is designed with pistons parallel to this axis.

A complete installation as used on catapults consists of one hydraulic pump direct driven by a small, slow speed electric motor, both of which are mounted on a common hollow bedplate which also serves as an oil reservoir. The variable delivery pump furnishes hydraulic power to operate two constant displacement hydraulic motors. One of these motors, acting through a reduction gear, trains the catapult around its turntable while the other, through similar gear, retracts the launching carriage. A three-way cock can be set for the operation of either motor. Any other number of motors within the capacity of the pump could be connected up to operate singly or together in either direction and with variable loads. The piping used on catapults is heavy copper tubing and all fittings and valves are of the high pressure union type.

The hydraulic pump and motor are somewhat similar in internal appearance and operation, except that in the pump, Figs. 2 and 6, the cylinders revolve eccentrically to the shaft and discharge liquid at pressures or volumes dependent on the degree of eccentricity whereas the motor utilizes this high pressure liquid to revolve the cylinders and drive shaft. Motor horsepower can be determined in the usual way by means of a Prony brake but, generally, ample allowance should be made for the starting torque which in catapult operation is usually much higher than in normal operation. Where slow, finely regulated speeds are desired, a motor should be selected that is capable of doing the required work

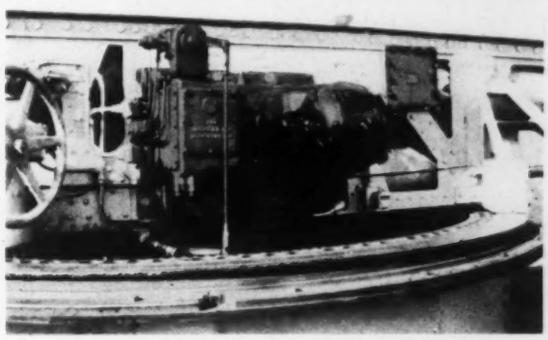


Fig. 5—Complete installation of electro-hydraulic equipment on catapult

at between 300 and 400 pounds pressure.

The main structure of the catapult is a steel girder made of alloy steel to reduce weight and increase strength. This girder is supported on roller bearings rotating on a circular turntable track similar to that used for the commercial catapults installed on the North German Lloyd liners "BREMEN" and "EUROPA," Fig. 4. To the girder is attached the engine, either on the inside or the outside.

Initial Speed Is Stepped Up

The engines used in these installations may be the compressed air type or the explosive charge type such as used by both the United States and British Navies. The air type requires suitable storage tanks for high pressure air and the powder or cordite type incorporates an expansion chamber to reduce the explosion pressure to suitable engine pressure. The engine piston may have either a pull or push action as it moves at a comparatively slow speed. This initial speed is stepped up by passing the towing cable, attached to the engine crosshead and the launching car, over a series of sheaves. The sheave ratio is proportioned to give the launching car the desired speed.

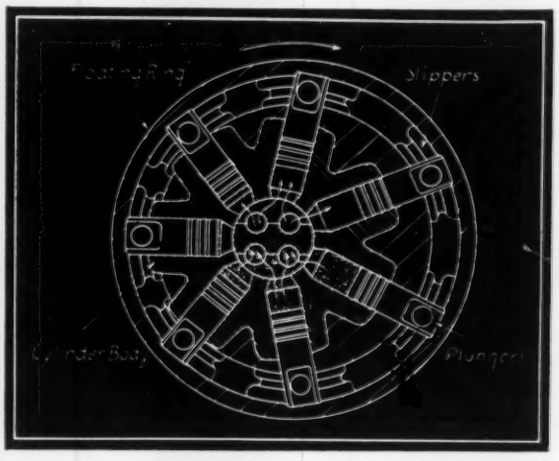


Fig. 6 — (Left) — Internal view of pump shown diagrammatically in Fig. 7. This is another type of pump used on United States Navy catapults for controlling the power. Fig. 7— (Right)—Diagram of Hele-Shaw pump with floating ring in maximum off-center position to the right. Direction of discharge reverses while direction of rotation remains the same

On the upper side of the girder are a pair of perfectly straight greased steel tracks on which the launching car travels. At the rear end are the devices to hold the car back until ready to shoot and at the front end of the girder are the brakes required to stop the car at the end of the run. These brakes are similar to gun recoil mechanism and will stop in a few feet a heavy car traveling at high speed without damage to the car. The towing cable is important and usually is made of plow steel wire with the ends set securely in special zinc terminals.

The launching car is the most ingenious arrangement devised for catapulting as it has so many functions to perform. The upper side has to engage, hold and release any type of seaplane. The car also must engage the safety devices, connect to the towing cable, attach to the car release mechanism, fasten on to the retracting chain and contact with the buffer brakes. Last but not least it must support a heavy load, traveling at high speed and stopping almost instantly.

Needless to say the foregoing, due to restrictions placed on publication of more specific details, is only an outline of the principal features of the modern naval catapult but it will indicate the many unique problems involved in the design of these leviathans which would make the ancient catapults of Carthage look like Lilliputians' toys. The modern catapult truly is the result of the selection and application of design principles originally evolved in widely divergent basic industries, intelligently brought together and adapted to create an effective design.

Acetylene Group Elects Officers

OFFICERS elected by the International Acetylene association at the close of its thirty-second annual convention held recently in Chicago, included: President, W. C. Keeley, Jr., National Carbide Corp., New York; vice president, E. J. Hayden, the Linde Air Products Co., Chicago; secretary, H. F. Reinhard, J. B. Colt Co., New York; and treasurer, W. E. Cotter, Union Carbide Co., New York. The latter two take the place of A. Cressy Morrison, New York, who is retiring as secretary-treasurer after holding that post for 25 years.

Mr. Morrison was awarded the Morehead medal by the convention. This medal is awarded annually to "the person or persons who, in the judgment of the association's officers and board of directors have done most to advance the industry or the art of producing or utilizing calcium carbide or its derivatives."

Correlating Design and Foundry

By Alex Taub

IMPROVED understanding between the men who design the part and the men who produce it cannot help but have a beneficial effect. Some methods by which designers can insure more satisfactory castings by collaboration with the foundry are discussed in the accompanying abstract of a paper presented at the annual meeting of the Mechanical Engineers. Mr. Taub is research engineer, Chevrolet Motor Co.

BEFORE a part is ready for manufacture it must include many economic considerations, the most outstanding yet most often neglected being that branch represented by the foundry. Designers have been notorious in the past for their neglect of necessary foundry considerations.

Price per pound of a casting is the true measure of the extent of designer—foundry correlation. The difference in cost between iron at the cupola and the cost per pound of the casting on the foundry floor is the final arbiter as to whether a job has been well done.

Know How Castings Are Made

One does not expect a designer to be a foundry expert, since the foundry art is a lifetime's study. However, he is expected to know approximately how his casting should be made in order that his design may not create unnecessary cost-producing hazards.

The external cores are the first sign of design weakness. They must be tolerated where necessary, but forever remain a red-flag point to be eliminated at the first opportunity. Elimination or reduction of internal cores should be given consideration, but only with the co-operation of the particular foundry available.

Open-mindedness on the part of the designer is a most important requisite. The foundryman must not only be heard and heeded, but quite often must be tempted to discuss his ideals. Perhaps a small modification might permit the development of new foundry practice.

Bulk to the designer may mean only the total size and weight of a given casting. The true bulk is the overall size of the flask necessary to make that casting. If the general dimensions of the casting are such as to require a considerable amount of waste sand, the molding equipment must be larger and therefore slower than necessary. This principle of flask bulk should be borne in mind with every type of casting. Sometimes a projecting boss or point may require 2 inches or so additional flask, placing molding of the casting just outside the capabilities of a lighter and faster machine.

Wall thickness is the haven for the designer who wishes to reduce weight; yet actually this is where weight cannot be reduced unless walls prior to change were thicker than good practice would dictate. Light walls breed every known type of foundry loss, and during the process of manufacturing quite often give trouble in handling.

If weight is to be eliminated, it must be done by shortening walls and eliminating parts; in other words, by designing less weight into the product.

The designer seldom feels that it is within his scope to aid with the matter of producing clean castings. He feels that this is the business of the foundry, and if the castings are not clean the foundry is at fault. There is no doubt that good foundry practice goes far in insuring clean castings; nevertheless, this ideal could be attained more easily if the designer would co-operate with the foundry in this matter.

Designers Should Subdue Impatience

To obtain the fullest benefits of design-foundry co-operation, it is necessary to overcome engineering impatience. Too often an engineer who has given every possible consideration to his foundry problems in his design considers his job done. He immediately hounds the foundry for sample castings overnight. These castings are quickly machined and converted into an experimental unit for development work. This is a great mistake. First, the foundryman has not been given sufficient time to review the feasibility of the suggestions that they may wish to have incorporated in the casting. Further, they have had no opportunity to check even near-production methods for obtaining the casting.

The foundryman and the engineer are equally interested in the final results of their joint product. Alone their scope is limited; united their progress will be continuous.

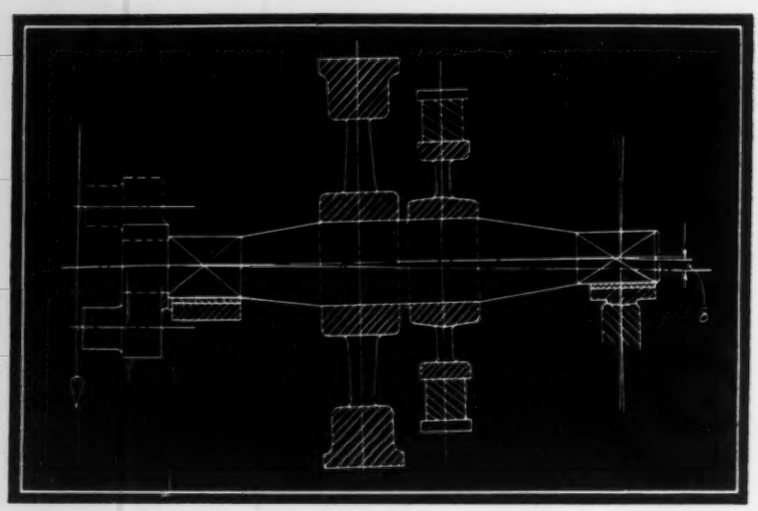


Fig. 1—Shaft system of a reciprocating engine of the side crank variety. Outboard bearing is elevated to avoid irregularities in alignment of crosshead and connecting rod

Shaft Deflection and Its Influence on Bearing Design

By H. F. Shepherd

THE torsion moments applied to machine or engine shafts usually are of small importance compared to the transverse bending moments due to applied force, gravity or rotational effects. Shafts loaded transversely may be divided into two classes, viz:

I.—Shafts in which combined stresses are required to be below the fatigue limit. The resulting deflections are tolerated.

II.—Shafts which are required to carry transverse loads with minimum deflection. The stresses may be of extremely small magnitude.

There are border cases between these two in which mass loading and shaft stiffness in the relation $\sqrt{M/F}$ determine the period of lateral vibration, the whipping or critical speed and the speed of wheel "shimmy" when disks or flywheels are overhung. In this relation $M=W/g$ and F=force required to produce unit deflection.

Conditions of the latter sort automatically transfer the shaft system from Class I to Class II. This transition is common today as all classes of machines are being speeded up.

Not only the service required of the machine and the $\sqrt{M/F}$ relations of its shafting systems determine the classifications in which the latter are placed; the types of bearings employed and their mounting may define the system, or the designer may choose to place it in Class I and select adaptable bearings and mountings.

Transversely loaded shafts are beams under alternate stresses. Once per revolution each "fiber" on the shaft circumference passes through a cycle, finding itself at equal intervals in the following positions:

1. Neutral axis
2. Outermost fiber in tension.
3. Neutral axis
4. Outermost fiber in compression

The bearings are the supports furnishing the reactions which preserve the equilibrium necessary to keep the shaft in its location. Fundamentally only two fixed pivots are required to locate a revolving system. Considerations of stress, deflection, or both may indicate the use of a number of bearings supporting the same shaft. Whether the shaft is to be regarded as a continuous beam in these circumstances is again a problem to be considered.

Reciprocating engines of the side crank vari-

DISCUSSION — or one might say controversy — has for some time centered on the various practices followed in mounting machine shafts. This article therefore will be found particularly pertinent, especially in the comparisons made between the methods adopted by machine tool builders and the designers of internal combustion engines.

ety have a shaft system such as indicated in Fig. 1. To avoid irregularities in the alignment of the crosshead and connecting rod due to inclination of the crankpin from the horizontal position as a result of shaft deflection, the outboard bearing is elevated until that element of the crankshaft which lies in the main bearing seat is horizontal or at least parallel to the guides if they are flat. Then the plane of the circle of the crankpin orbit is normal to the flat crosshead guides.

Outboard Bearing Is Set High

To accomplish this the outboard bearing is set high a distance such as δ in Fig. 1. No accurate determination of the amount of this elevation is required. The bearing is lifted on adjustable wedges provided for the purpose until the crankpin end is equidistant from a plumb line at the top and bottom quarters of rotation.

This represents the best engineering possible and good mechanical practice. To make the shaft deflection under flywheel and rotor weight insignificant an unduly heavy and expensive shaft would be required.

The outboard bearing for this service requires a self-aligning seat unless the duty is so severe that a loose member in the bearing stand is not permissible. In that case the whole assembly is tipped until the bearing is parallel to the line of shaft inclination.

In a machine tool spindle the conditions just

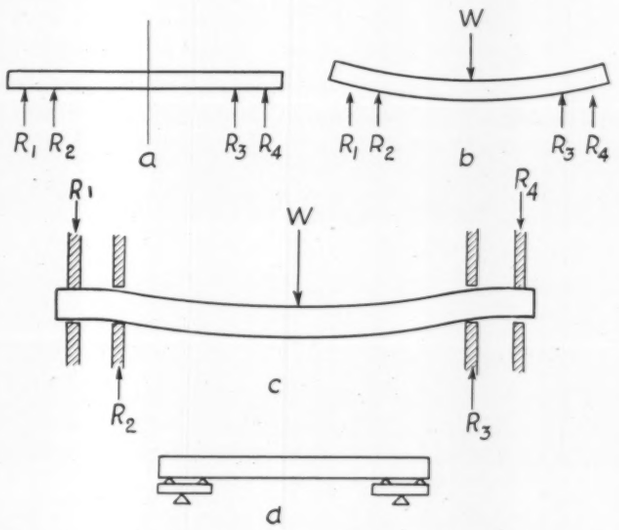


Fig. 2—Conditions induced by beam loading with multiple bearings. Proper mounting for double or multiple row bearings is shown schematically at D

described are intolerable. Predetermined reactions establish the bearing dimensions. The spindle being made so stiff that the deflection along the supported element of its length is insignificant, rigid bearings of any desired sort may be used.

After suitable dimensions are chosen it may happen that antifriction bearings of bore equal to the shaft neck diameters lack the required load capacity. Then multiple row bearings are suggested, two or more bearing units or two or more rows of rollers and balls being contained in each box, Fig. 3.

If the boxes are rigid the condition is shown schematically in Fig. 2*a*. This, of course, is un-

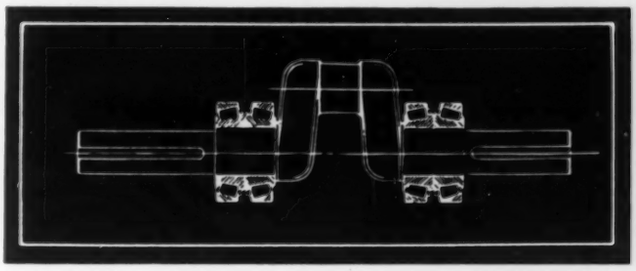


Fig. 3—Typical mounting of multiple row bearings in which two or more bearing units or two or more rows of rollers are contained in each box

sound in theory. The deflection of the shaft due to the weight alone will relieve the outermost bearings of duty as may be demonstrated by resting a straight edge on four gage blocks of equal thickness, two blocks being placed near each end. The application of load to the middle of the beam results in the condition in Fig. 2*b*.

Restraint Alters Bearing Loading

It is objected sometimes that the function of multiple row bearings is to limit deflection as in Fig. 2*c*. If the bearing clearance is small and the shaft quite flexible it is evident that restraint of this nature results in the inner bearings carrying not only ½ W each but the straightening force as well so that R_2 or R_3 equals ½ W plus R_1 or R_4.

Such applications have survived because of the great overload capacity of the better antifriction bearings and because the solid seats were not as rigid as was assumed.

Where double or multiple row bearings are required for Class I application they should be mounted in self-aligning seats as represented by the diagram, Fig. 2*d*.

Such seats are not used, however, in engine work. The quality of surfaces working in opposition is maintained only when the motion is such as to restore the oil film continuously and automatically. The crunching of loose boxes in their seats soon destroys all evidence of the original accuracy of the surfaces since oil is squeezed out and abrasive oxides are formed of the metal worn away.

Two single row coned bearings, one at each end, as in Fig. 4, are in approved use for crankshafts. This application is approved by the bearing makers for bearing spacings up to 30 inches. They specify that the frame must be sufficiently

rigid to withstand the small end thrust due to the inclination of the races.

The spacing is defined to limit the length of shaft so that the difference in expansion between the warm shaft and the cooler housing cannot cause excessive bearing loading due to end thrust. In practice it is found that the bearings must be set so as to allow some end play when the assembly is cold, not only to permit expansion but to allow for bearing freedom under shaft deflection. If the bearings are set up too snugly, pronounced heating may result due to both causes, deflection setting up loading of the single rolls at their opposite ends as in Fig. 2*c*.

Certain special grinding machines of the continuous automatic type are so adjusted. They are incapable of turning out a product of the required accuracy until they are operated a few hours to bring their spindles to working heat.

This again is intolerable for machine tools used for jobbing. They operate on a wide variety of products over a great range of speeds and loads. Such machines require spindles of great inherent stiffness. These are located at one end by adjustable opposed cone bearings and merely are guided at the other by some form of bearing capable of centering the shaft but offering great axial freedom. This may be acquired by the slipping of the outer race in its housing or by end guiding straight rollers with shoulders on the inner race only, the outer race having a straight ground bore.

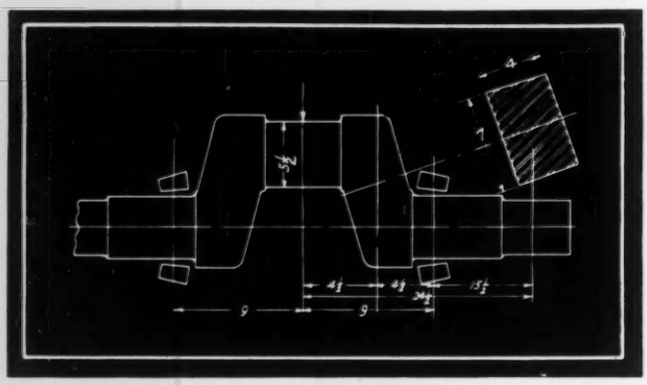


Fig. 4—Two single row coned bearings, one at each end, are approved by bearing makers for spacings up to 30 inches

In engine design certain models are provided with three or more bearings and two flywheels as in Fig. 5*a*. When the overhung wheels are carried on a shaft with two or more cranks the shaft fails to find its seat in the intermediate bearings if they are in line. Any attempt to straighten the shaft by setting down the intermediate bearing caps results in loading the bearings next to the flywheel abnormally, since each then is obliged to carry not only the wheel weight and half the piston load but also half of the cap reaction. If the distance *X* equals half the distance *Y* the gravity load on the end bearings will be increased 50 per cent when the intermediate caps are set down so that all journal centers are in line thus preventing the resisting moment of the shaft from assuming any part of the burden.

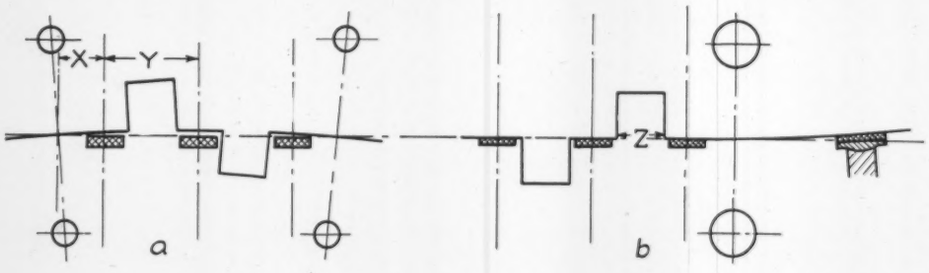


Fig. 5—Schematic representation of conditions with engine design provided with three or more bearings, and revised design

May Elevate Intermediate Bearings

In steam engines, gas engines and diesel engines where bearing burdens are heavy this is not a desirable condition. It is quite possible to make the outer bearings large enough to assume the load due to masses placed unfortunately at a mechanical advantage but it is not economical to do so. A practice originating with early Westinghouse engines provides a wedge under intermediate bearings so that they may be elevated to contact with the shaft which assumes and runs in the natural bow due to its gravity loading.

Later practice is to eliminate one wheel. All flywheel effect is concentrated at the power takeoff end. An outboard bearing is set sufficiently high to allow shanked part of the shaft to rest and run in perfectly aligned bearings, Fig. 5*b*.

The setting is made by erectors in a simple manner. The crank is turned downward and the dimension *Z* is taken. It is turned upward and a measurement is made at the same place. If the gap opens when the crank is down and closes when it is up the outboard bearing is elevated until the measurements are equal in any crank position. The converse procedure may be required if the outboard bearing is already high.

Shafts for multicylinder engines are not designed as continuous beams nor is any allowance made for possible support of the shafts by caps on bearings remote from the cranked section under load. Such practice is dangerous for two reasons. Close clearances are necessary for this mode of support and engine clearances are made as large as possible without permitting "knocks." This is essential to establishing and preserving adequate oil films. At times it is necessary to operate engines with large bearing clearances due to urgent need for power. Engine bearings

are loaded heavily and all "pinch bar" effects must be avoided.

Two-cycle single acting diesel engines are capable of operating without any crankshaft bearing caps as the preponderance of force is in the downward direction at all times.

A contrast between engine building practice

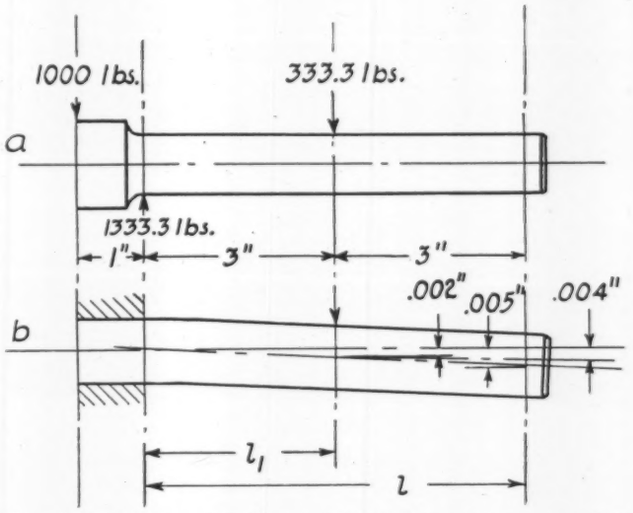


Fig. 6—Basis for formulas with spindle nose so stiff that its deflection is negligible

and machine tool design appears again in three-bearing machine spindles. The spacing of spindle bearings is determined quite often by the gearing in the headstock. Since the stiffness of a shaft varies as the fourth power of its diameter it is easy to secure any desired stiffness of the spindle by swelling its middle section. This may not be possible in all cases. Speeds have advanced until metal working machinery vies with woodworking machinery and at the same time it is required to carry far greater reactions. This calls for geared drive and the spindle pinions are, of necessity, comparatively small. The mode of assembly may require a small spindle diameter in order that nose bearings of the antifriction type may be stripped off over the rear end.

Introduce Three Bearing Spindles

For these reasons spindles having three bearings have been introduced. The following simple treatment suffices to establish some facts. The deflection formulas are to be found in *Mechanics Applied to Engineering,* by John Goodman.

Assume that the spindle nose is so stiff that its deflection is negligible. Make the spindle between bearings a shaft of uniform section one inch in diameter. The cantilever spindle load is 1000 pounds, 1 inch removed from the center of the nose bearing. The bearings are spaced three inches apart. All of this is shown in Fig. 6*a* on which the resulting reactions are indicated.

First treat the spindle as though it were on two bearings three inches apart, the steady bearing being removed. Fig. 6*b* shows the spindle as a cantilever with the nose fixed. The deflection at a point six inches removed from the nose bearing then will be

$$\delta = \frac{W l_1^2}{2 E I}\left(l - \frac{l_1}{3}\right)$$

$$= \frac{333.3 \times 3^2}{2 \times 30{,}000{,}000 \times 0.05}\left(6 - \frac{3}{3}\right) = 0.0050$$

The deflection under the load will be

$$\delta = \frac{W l^3}{3 E I} = 0.0020 \text{ inches}$$

Projecting the straight line it is evident that if the shaft is forced into line at the three bearing centers the outer end must be deflected 0.001-inch in a direction opposed to the original flexure. For this condition

$$\delta = 0.001 = \frac{W l^3}{12 E I}$$

$$W = \frac{0.001 \times 12 E I}{l^3} = 83.3$$

Applying this, reactions are as in Fig. 7. The

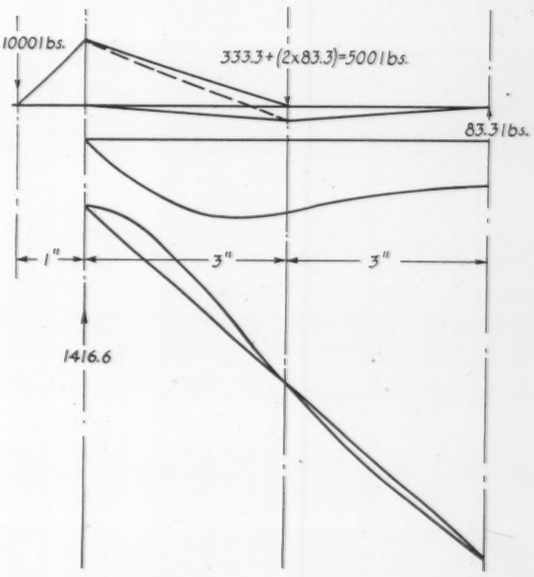


Fig. 7—Bending moment diagram extended by two graphic integrations to show elastic curve

bending moment diagram is extended by two graphic integrations to show the form of the elastic curve. It will be noted that the points where the reactions cut this curve lie in a straight line proving the formulas correct.

It may be stated as a rule that all attempts to limit deflection by bearing restraint result in increased bearing loads and often in increased costs assuming that all such bearings are designed with full knowledge of their duties. No one rule may be laid down, however, to guide designers of all classes of machinery. The extra bearing capacity required for shaft restraint may be well worth its cost in some applications.

Editorial

Successful Business in 1932 Hinges on Ingenuity in Design

NOT a few of the companies reported to be doing well in spite of the generally poor state of business attribute their gratifying success to improvement in the design of their products. During the past few months several studies have been made of concerns whose sales in 1931 exceeded those of 1930. These investigations show many instances in which redesign is the very spearhead of the battle against the depression. Time and time again in the case studies of successful companies is found this formula: "We improved our product, advertised it extensively and launched an aggressive sales campaign."

This does not mean that every manufacturer of machines or of machinery parts can increase profits by this method. Much depends upon the condition of the market and upon many other factors, some of which are beyond the control of the manufacturer. But where the opportunity exists, many companies can improve their positions substantially by directing their major efforts toward improvement of product through redesign.

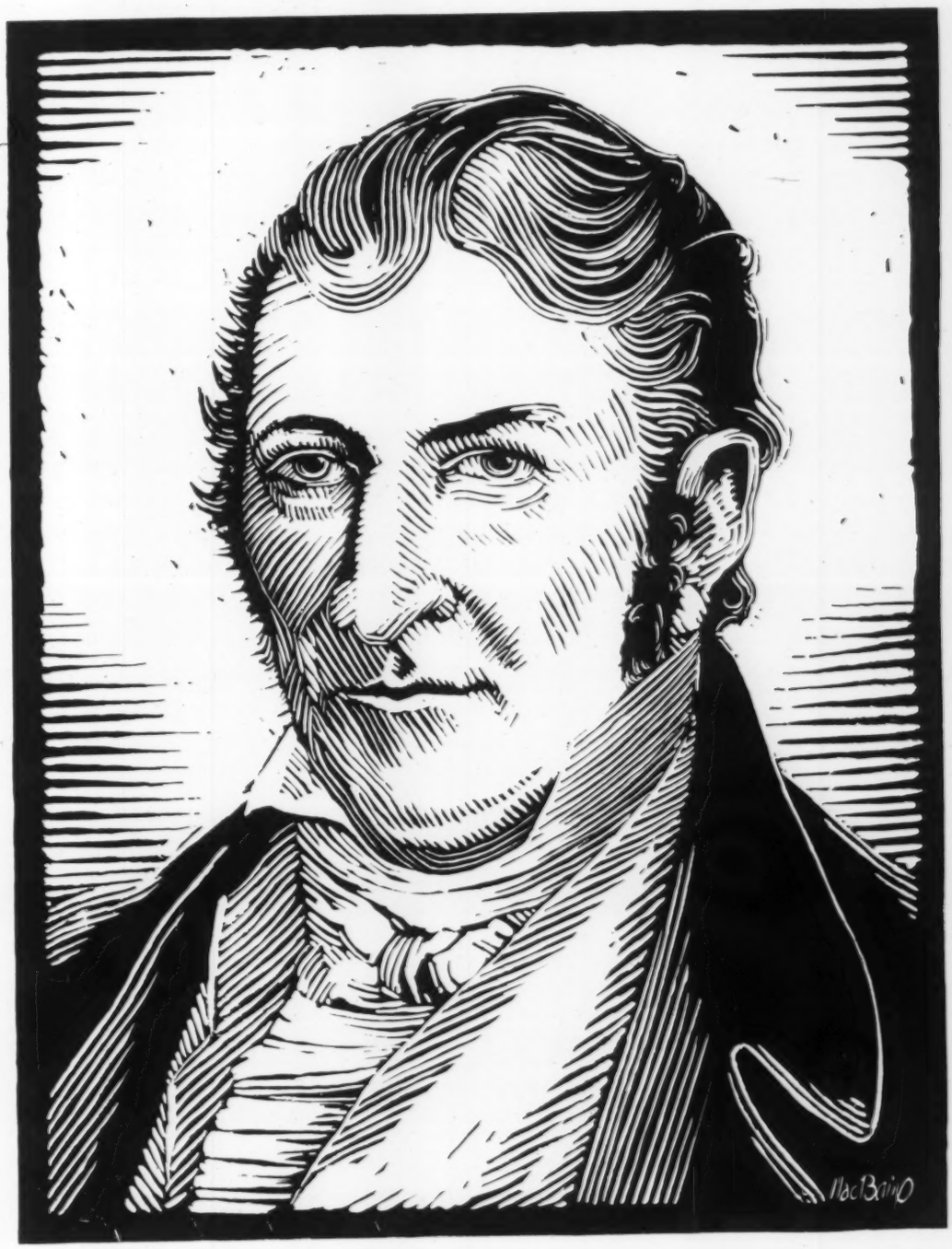
Engineers should welcome this chance. The situation virtually is a challenge to their skill and ingenuity. Today as never before design to be effective must embrace not only a high degree of mechanical perfection but also those qualities of customer appeal, salability and economy which have been emphasized in MACHINE DESIGN during the past year. Engineers who combine unusual ingenuity in the technique of design with ability to take advantage of low prices of materials and parts can provide the keystone essential to success.

Watch the New Style!

TWO radical changes are taking place in connection with the welding of machines and machine parts. One is the attitude of the buyer or user and the other the development in welding technique.

It readily is noticeable that designs incorporating welding which would have met with unfavorable reactions only one or two years ago, now are accepted and in many cases welcomed. On the other hand it can be seen that welding procedure, particularly since the introduction of torch-cut and formed parts, has progressed to the point where the comparatively crude creations of early days of welding need be considered no longer.

Put these two together and what do we get? A welding-minded public ready to accept the new style, and a gradually changing concept of what constitutes strength, beauty and efficiency in design.



Eli Whitney

Master Designers

Eli Whitney

RECOGNITION is seldom accorded a designer for all of his contributions to science. A single outstanding invention, or a development that catches public fancy is heralded widely, while other equally significant innovations receive scant attention. Such is the case with Eli Whitney whose cotton gin revolutionized industrial history, but who in addition performed a lasting service to all industry by the development of the system of interchangeable parts and the design of the first milling machine.

WHITNEY, born at Westborough, Mass., in 1765, early exhibited more intense interest in his father's shop than in the more prosaic duties of farming. He performed a valuable service for the Continental army by manufacturing nails. The manufacture of walking sticks paid his expenses through Yale, where he astounded his professors by repairing machinery believed too intricate for American intellect.

WHILE in Georgia, it was proposed that he set his talents to solving the great need of the South, an efficient method of cleansing cotton. His first model of a cotton gin was an instant success, and today gins differ only in minor details. Unsuccessful attempts to patent the device and poor business sense cost Whitney practically all of the profits to be gained from the machine.

FAILURE of this venture to yield financial returns led Whitney to apply for a contract for making muskets. It was here that the system of interchangeable parts was first introduced, Whitney developing specialists, each of whom made his part so accurately that the final assembly was a perfect mechanical entity. Much of the machinery used in the production of arms had to be designed, and it was for this purpose that the versatile inventor built the milling machine believed to be the first device of its kind.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Style Consciousness in Design

To The Editor:

THE past few years have shown a marked beginning of an industrial style conscious world. As discussed in previous issues of MACHINE DESIGN, there is an insistent demand for beauty in industrial products, combining the utilitarian with distinctive eye appeal. The American people want beautiful things, whether it be an automobile or a vacuum cleaner.

Selecting at random the leading manufacturers in industry and looking at their products, it will be readily seen why the public has accepted them. They evidence not only good value but at the same time are the latest in style, color and design. The style trend is all around us, in the home, in the air, on the streets and even in transportation; it now is a part of our civilization.

Look at the change in automobile design. The car of 1920 no matter how good mechanically could not be sold today. As a matter of opinion I would say that fifty per cent of the motor cars sold today are purchased on their appearance alone. Mechanical perfection is taken as a matter of course; it's the lines and color scheme that sells

We are fast becoming nationally style conscious, yet there are some designers, perhaps I had better say, "some manufacturers" because they are closer in touch with the sales problem, that have yet to see the "handwriting on the wall."

I know a manufacturer of woodworking machines that could make a much better line of machines if he would get in step with the style trend and redesign into the modern tempo.

There is a manufacturer of electric motors that year in and year out sticks to an old fashioned type of motor frame, unsightly and wholly unattractive. He talks of being down to rock bottom on his costs, but he would be surprised greatly if he did a little redesign with pressed steel and arc welding in mind.

It behooves each and every designer and manufacturer to consider the newer alloys, the plastics, the newer methods of plating and finishing, die casting and arc welding methods and all the advanced modes of today. Let them then go over their products part by part and piece by piece, with an open mind and see where and how they can be improved. Let them analyze color schemes, styling, symmetry and all the essentials of modern design and merchandising and the net result will be something distinctly worthwhile.

The old saying "Let a man build a better mouse trap, though his abode be in the woods, the public will make a beaten track to his door" is no longer true. Today the designer or manufacturer not only has to build a better machine but he has to style it, make it pleasing to the eye of the public, and then, through intensive sales effort, merchandise it. The latter is impossible without the other essentials. *Style in design,* here lies the economic salvation of the designer, engineer and manufacturer.

—J. R. M. MURPHY,
Lakewood, O.

To Check or Not to Check!

To The Editor:

REPLYING to the comments made by Mr. Schirmer in the December issue of MACHINE DESIGN, there is little doubt in my mind but that it is advisable to check drawings. When a corps of detailers are employed in detailing a machine it is necessary to check each detail thoroughly, for each detailer has his own views. It is doubly important when an experimental machine is not built first. The following system has been found to be quite successful.

After the designer has worked up the various units in part or in whole, the layout drawing is given to the detailers who draw each piece on separate sheets. In case a detail is to be superseded or changed radically, the original can be destroyed.

When the detailer's first drawing—probably the main casting—is completed it is handed with the layout drawing to the checker. The detailer receives a blueprint of this from which he details the smaller pieces. A blueprint will shrink but will not affect the scaling for the smaller parts.

The designer's layout has overall length,

breadth, height gear center distance and clearance dimensions on it, especially when these are held to close tolerances. After this drawing is checked it goes to the pattern maker. In this way valuable time is saved and the pattern department will not be rushed later on when the rest of the small details are completed.

The original designer then looks over all the details, satisfying himself that the important dimensions check with his calculations and that the various tolerances upon which the checker has communicated with him are correct. This does not mean that the designer necessarily burden himself with the trivial details, for during the course of detailing he has kept in touch with the detailer and checker.

When he is satisfied with all these details, after making any minor changes on the pattern-maker's blueprints, he releases them to the shop. These details then are taken by a junior designer who proceeds to make full sized assembly drawings of each unit in three views.

It will be found that these drawings are an additional check, in fact the final check, not so much for tolerances, but for clearances, interferences and co-ordination of parts.

As the details have been traced with pencil on paper, they may and should be traced neatly in ink on cloth after the first machine is completed or any time when convenient for the squad leader to work them into his schedule.

—F. A. FIRNHABER,
Waynesboro, Pa.

Obsolete Materials Must Go

To The Editor:

A FEW words might be added to your editorial in November to expose more completely the machinery obsolescence situation, especially as regards materials, which generally is known to exist in manufacturing industries. Material obsolescence is inexcusable when one has so many opportunities to keep informed of the newer products available. Material salesmen are always at hand and are only too glad to discuss their wares. In addition, many trade details of the technical research being carried on by their parent organizations are freely given.

The wastes in construction materials by excess weight alone is enormous and can be traced directly to antiquated design. Aircraft performance has taught us that tremendous pressures can be withstood by exceedingly lightweight structures under the most difficult stress conditions. What other mechanism is there for comparison which is required to withstand diving speeds of over two hundred miles per hour in all kinds of weather and which must be so designed that its weight can be supported both on land and in the air? There does not seem to exist any reason why other machine builders cannot do likewise and thus pull themselves out of the rut of obsolescence in which passe' design, just as much as out of date material, is now holding them.

—H. R. POLLEYS,
New Haven, Conn.

Calculating Centrifugal Tension

To The Editor:

IN CONNECTION with machine design problems pertaining to belting, flywheels, etc., I have found that usually in centrifugal tension calculations the formula most commonly used requires the weight of a piece of material one inch in section and one foot long which is a unit not given in tables and handbooks and cannot be derived without dividing the weight per cubic foot by 144 or by multiplying the weight per cubic inch by 12. The method is cumbersome.

As generally given the formula also requires that we square the velocity of the material, the velocity to be in feet per second. This quantity also generally is unknown and must be obtained by a computation involving the diameter of the circle and the number of revolutions per minute.

To simplify matters and in order to produce a formula that is applicable to quantities more commonly known or more easily determined I have derived the following:

Centrifugal tension in pound per square inch

$$= \frac{W D^2 N^2}{1{,}690{,}000}$$

where

W = the weight of the material per cubic feet
D = the diameter in feet
N = the number of revolutions per minute

For example, let us suppose that we wish to design a cast iron flywheel for a steam engine the diameter of which will be 4 feet. The flywheel is to make 420 revolutions per minute. What tension will the cast iron have to resist?

The weight of cast iron is about 450 pounds per cubic foot.

Now, substituting in the above formula we get:

$$\frac{450 \times 4 \times 4 \times 420 \times 420}{1{,}690{,}000} = 752 \text{ pounds per sq. in.}$$

Prof. Goodman states that an old millwright's rule limited the speed of cast iron flywheels to 1 mile a minute, or 88 feet per second. This, when computed, shows a stress of about 800 pounds per square inch. Therefore 752 pounds per square inch as obtained above is satisfactorily close to the limit.

—W. F. SCHAPHORST,
Newark, N. J.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

TWELVE years of experimenting by Frank B. Stearns, pioneer in the automotive industry, have materialized into an eight-cylinder internal combustion engine based on diesel principles but embodying many refinements in design. The unit was demonstrated to a group of engineers recently in his private laboratory in Cleveland. It is of aluminum construction and operates on the two-cycle principle. Two crankshafts are utilized, at the top and bottom of the engine, the eight cylinders and sixteen opposed pistons being disposed in diamond shape around the center of the unit.

* * *

Gives Idle Engineers Chance to Study

IDLENESS may become an asset when an engineering school such as that at Columbia university opens its doors to unemployed professional engineers. Applicants must secure a certificate from the engineers' committee of which H. de B. Parsons is chairman, showing that they are accredited members of the profession and that they are idle through no fault of their own. They present these credentials to Dean Joseph W. Barker who assists them in arranging their class attendance.

"The principal purpose for opening the classes without fee or credit to the engineers," Dean Barker said, "is to preserve the morale of these skilled men during a period of enforced idleness."

* * *

Forecasts Increased Use of Alloy Steels

ONE-third of all the steel produced in the next 10 years will be stainless, Joseph Petch, Republic Steel Corp., predicted at a recent meeting of the Chicago chapter of the Institute of Scrap Iron and Steel. He said that American industry is entering into an age of alloy steels and ultimately companies producing them will have to install special induction furnaces to enable them to use alloy scrap.

* * *

Plans Survey to Analyze Problems

SINCE its inauguration the American Die Casting institute has been engaged in research and statistical work but now proposes to take a closer analysis of its problems in order to give it greater stability. The institute has a two-year arrangement with Case School of Applied Science, Cleveland, whereby it assumes one-half the expense of special equipment to conduct tests as to tensile strength at all temperatures, analyses, microphotography, impact, elongation, compressive strength, hardness, and steam baths for accelerated corrosive tests.

* * *

Foreign Farmers Prefer American Machines

TRIBUTE to the inventive genius of American manufacturers is found in the desire of farmers in other countries for American-made farm equipment. Practically every country where agriculture is at all progressive has demonstrated to its own satisfaction that the labor-saving and cost-reducing machines produced in American factories are superior to those of other lands. These facts were brought to light by a recent investigation made by the department of commerce.

In this belief they are in accord with farmers of the United States, who, as President O'Neal of the American Farm Bureau federation recently stated, appreciate the need for lowering production costs through proper application of power and machinery.

* * *

Distribution Problems Still to Be Solved

BASIC changes in mechanics, starting with the period of civilization when all accomplishment was the result of handicraft, were outlined by Dexter S. Kimball, dean of engineering, Cornell university, and past president of the American Society of Mechanical Engineers. Handicraft shows no solution of the problems of civilization as regarding proper distribution or even the necessities of living, Dean Kimball declared.

Now for the first time in history production capacity can put forth more food, clothing, and shelter than is required—in the United States. Mass production has made the worker dependent on capital, but is making industry responsible for the producing. Now for the very first time in social history we are approaching abolition of want, distress, and disease. Problems of production are in process of solution, but problems of distribution of industrial returns are still unsolved.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

UPON Dr. Calvin W. Rice has been conferred an honorary membership in the American Society of Mechanical Engineers. This gesture comes as Dr. Rice is celebrating his 25 years as secretary of the organization and is a fitting tribute to his high ideals for the position the engineering profession should occupy.

Dr. Rice was born at Winchester, Mass., Nov. 4, 1868. After attending public schools in Boston, New Haven and Winchester, he spent four years as a student at Massachusetts Institute of Technology from which he was graduated in 1890 with a B. S. degree in electrical engineering. He then held successively numerous positions from which he obtained a rich and varied experience in electrical, hydraulic and steam engineering, combined with managerial and executive work. With this background Dr. Rice was made secretary of the American Society of Mechanical engineers in 1906.

His ability to build organizations is proved in the success of the society of which he is secretary. Even before 1906, however, Dr. Rice performed noteworthy service to engineering organizations in America. After joining the A. I. E. E. and A. S. M. E. in 1897 and 1900 respectively, he with others participated in the first co-operative project, namely the establishment of the John Fritz gold medal of the national engineering societies.

HIGHEST of American engineering honors, the John Fritz gold medal has been awarded for 1932 to Dr. Michael I. Pupin of Columbia university for his achievements as a scientist, engineer, author and inventor. The award, which was unanimous, was made by a board representing the four national societies of civil, mining and metallurgical, mechanical and electrical engineers.

Dr. Pupin is professor of electro-mechanics and director of the Phoenix research laboratory at Columbia. Among engineers and scientists he is widely known for his research and inventions in connection with long distance telephone lines and for his advanced work in the passage of electricity through gases, electrical resonance, electrical wave transmission over long conductors, and other scientific subjects.

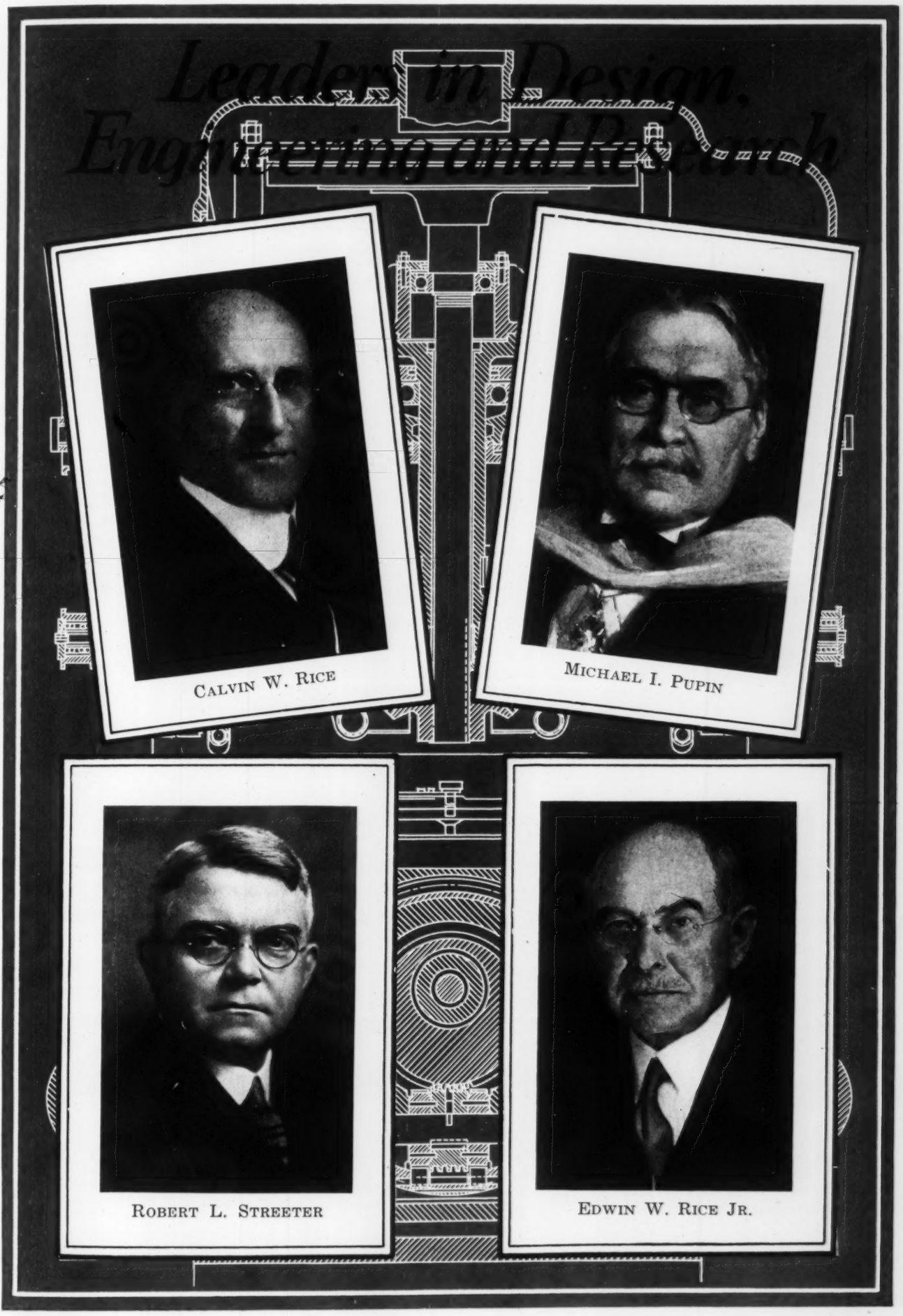
He was born a Serb in Idvor, Banat, Hungary, Oct. 4, 1858, and came to America as a boy. After many courageous struggles he won an opportunity for an education. In 1883 Dr. Pupin was graduated from Columbia, studied at the University of Berlin and received the degree of doctor of philosophy in 1889.

AN IMPOSING engineering record as a professor, author and executive belongs to Robert L. Streeter who recently resigned his position as vice president of the United States Aluminum Co., principal manufacturing subsidiary of the Aluminum Company of America. Graduating in mechanical engineering from Pennsylvania State college in 1903, he launched his career as an instructor there.

In 1905 he became affilated with the Lackawanna Steel Co. and was engaged in experimental and research work in the steam engineering department. Leaving the Lackawanna company in 1909, Mr. Streeter became instructor in the Buffalo, N. Y., technical high school in charge of machine design. Remaining in that capacity a year, he went to Rensselaer Polytechnic Institute as assistant professor of mechanical engineering, assuming charge of courses in machine design, steam and gas engine design and steam turbine design.

Entering the U. S. Army as a captain in 1917, Mr. Streeter took over the design of motorized units, consequently being promoted to the rank of major and made chief engineer of Rock Island arsenal. Later as a lieutenant-colonel he was made general manager of the arsenal. On October 1, 1919, Mr. Streeter became affiliated with the Aluminum Co. of America as chief mechanical engineer, at which time he organized its mechanical engineering department to design a large variety of machinery and equipment. He became vice president of the U. S. Aluminum Co. in 1921.

TO Edwin W. Rice Jr., conspicuous electrical pioneer and one of the founders of the General Electric Co., has been awarded the Edison medal of the American Institute of Electrical En-



CALVIN W. RICE

MICHAEL I. PUPIN

ROBERT L. STREETER

EDWIN W. RICE JR.

gineers for 1931. The citation accompanying the award reads: "For his contributions to the development of electrical systems and apparatus and his encouragement of scientific research in industry." The presentation of the medal will take place January 27 in New York.

The award constitutes one more episode in a long career of engineering and executive achievement, which includes a term of nine years as president of General Electric and the post of honorary chairman of its board which he now holds. Mr. Rice went into the electrical industry when both he and it were young. It was in 1880, just after he had been graduated from the Boys' Central high school of Philadelphia, that he accepted an opportunity to become assistant to Prof. Elihu Thomson, the arc light and alternating current pioneer, and went with Prof. Thomson to New Britain, Conn.

In 1892, when General Electric was organized, Mr. Rice was made chief engineer and technical director, eventually becoming senior vice president and later president. It was Mr. Rice who was chiefly responsible for the establishment of the now famous General Electric research laboratory, officially recommending that step to the board of directors.

Mr. Rice was born in LaCrosse, Wis., May 6, 1862. He has won many honors and has been active in a number of organizations. As an inventor he holds more than one hundred American patents.

* * *

W. C. Heath, formerly vice president in charge of engineering at Fairbanks-Morse Co., Beloit, Wis., has been elected vice president in charge of research engineering and factory production of A. O. Smith Corp., Milwaukee.

* * *

W. M. Young, formerly associated with the electrical engineering department of the University of Iowa, Iowa City, has joined the engineering research department of the Taylor Instrument Co., Rochester, N. Y.

* * *

James J. Ryan, mechanical development engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been appointed professor of mechanical engineering at the college of engineering, University of Minnesota, Minneapolis.

* * *

S. K. Hoffman has accepted a position as engineer with the Lycoming Mfg. Co., Williamsport, Pa. Up to the time of accepting his present post he was research engineer in the General Motors Corp. research laboratory, Detroit.

* * *

John E. Barkle has been appointed general manager of the South Philadelphia Works of the Westinghouse Electric & Mfg. Co. Upon the completion of his education at Dickinson College in 1901, Mr. Barkle became associated with the Westinghouse organization, successfully filling positions of increasing responsibility in the works department.

* * *

H. P. Charlesworth, vice president Bell Telephone laboratories, New York, has been nominated president of the American Institute of Electrical Engineers. He has served on many committees.

* * *

Ernest F. DuBrul has resigned as general manager of the National Machine Tool Builders' association, a post he has held since 1921. He was succeeded Dec. 15, by Boyd Fisher of Irving Trust Co., New York. Mr. DuBrul will enter private practice as consultant on finance, marketing and management.

* * *

Bancroft Gherardi, vice president of the American Telephone and Telegraph Co., was re-elected president of the American Standards association for the year 1932 at the recent annual meeting of the organization in New York. Other officers re-elected are: Cloyd M. Chapman, consulting engineer, United Engineers and Constructors, Inc., New York, vice president of the American Standards association and chairman of the ASA standards council, and John C. Parker, Brooklyn Edison Company, Brooklyn, N. Y., vice chairman of the standards council.

LEWIS TAYLOR ROBINSON, engineer in charge of the general engineering laboratory of the General Electric Co., died recently from a heart attack at his home in Schenectady, N. Y. He was 63 years old. Dr. Robinson was a veteran electrical technician, one of the widest known electrical engineers in the profession, and for 12 years the head of one of the principal laboratories of General Electric.

* * *

Frederic Samuel Jordan, for the past 30 years an outstanding figure in the nickel industry, died December 16 in New York at the age of 62. He was sales manager of the nickel department of The International Nickel Co. Inc.

Born in Berea, O., Aug. 28, 1869, Mr. Jordan began his business career at the age of 18 when he became a secretary in the Cleveland office of the Big Four railroad. A year later he became private secretary to H. P. McIntosh who was prominent in the Canadian Copper Co. When this company was merged into the organization of the original International Nickel Co., in 1902, Mr. Jordan came to New York as sales executive, a position which he held during the progressive development of the organization.

ASSETS TO A BOOKCASE

Review of Books Pertaining to Design

Design Principles

Analytical Mechanics, by H. M. Dadourian, cloth, 6 x 9 inches, 427 pages; published by D. Van Nostrand Co., New York, and supplied by MACHINE DESIGN for $4.00 plus 15 cents postage.

To effect economy of thought Prof. Dadourian has presented the subject of this book in a manner which enables the reader to acquire a firm grasp of the fundamental principles of mechanics with a minimum of mental effort. He has not, however, reduced his work to a collection of rules, forms to aid memory, and formulas. Rules and drill methods, he says, tend toward the exclusion of reasoning rather than toward efficiency in thinking.

Discussion of types of motion include that of translation and rotation, both being treated not only in the same general manner but developed along almost parallel lines. The simpler types of motion which generally are included under kinematics are given in this book as problems in dynamics.

Designers, particularly those who desire to ground themselves more securely in the principles of mechanics will find the volume an asset. While this is the third edition, its timeliness is preserved by the fact that many pages have been rewritten with the object of making room for new material and improving the presentation of the various topics. The author is Seabury professor of mathematics at Trinity college.

□ □ □

Hydraulics Discussed

Hydraulics for Engineers, by Robert W. Angus, cloth, 5½ x 8½ inches, 300 pages; published by Isaac Pitman & Sons, New York, and supplied by MACHINE DESIGN for $3.75 plus 15 cents postage.

With hydraulics becoming increasingly important to the designer, in view of the trend toward its use in operation of machinery, a book treating the subject from the broad angle will no doubt find an interested class of readers. Not only from this standpoint but also because Prof. Angus, the author, has succeeded in giving a practical bearing to his discussions. As a matter of fact Prof. Angus has had thirty years of experimenting and practice in the field of hydraulic engineering to parallel his experience as professor of mechanical engineering at the University of Toronto.

The subject has been treated without the introduction of difficult mathematics and there is scarcely a section in the book involving more than a knowledge of quadratic equations. The hydraulics of the turbine and pump are fully dealt with and application of the principles has been made to certain practical problems. Part two of the book is devoted to hydraulic turbines and centrifugal pumps. The first and third parts cover flow of water in pipes, orifices, weirs and open channels, and non-uniform flow.

□ □ □

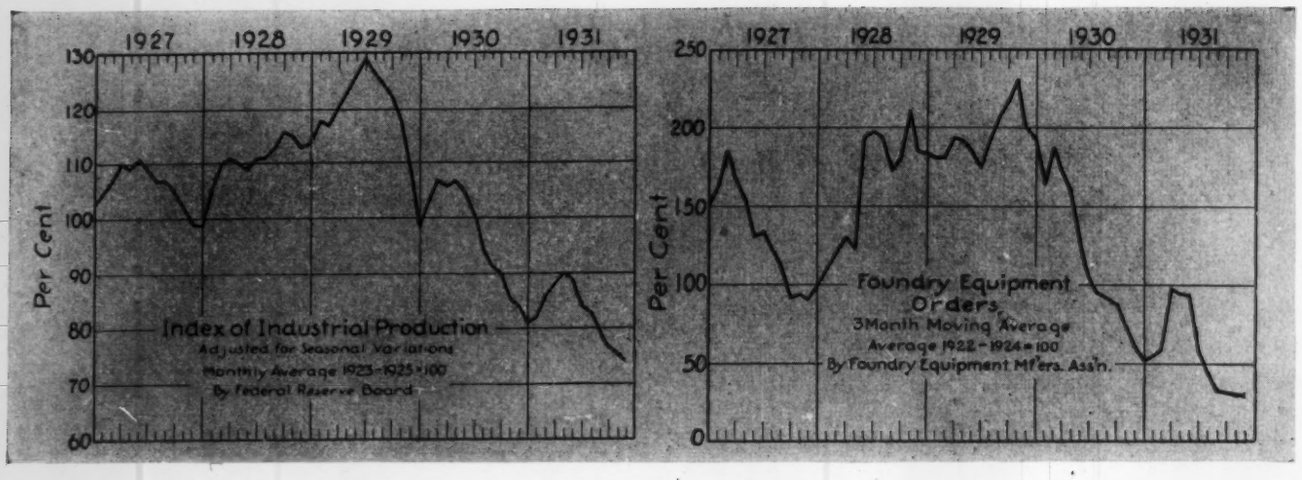
Electric Motor Design

Fractional Horsepower Motors, by A. H. Avery, cloth, 7½ x 5 inches, 152 pages; published by Isaac Pitman & Sons, New York, and supplied by MACHINE DESIGN for $2.25 plus 15 cents postage.

This is a practical book dealing with the principles of construction of fractional horsepower electric motors, a subject of popular interest due to increasing use of these units. Ratings of this class generally lie between 1/100 and ½ horsepower.

In the early part of the book Mr. Avery enumerates applications, the discussion of which consumes three and a half pages. Other aspects include selling points which take in price and appearance; efficiency, economic factors, etc. Chapter two begins with constructional features, under which requirements to meet competitive conditions are enumerated, and elasticity in design considered.

Both the designers of small electric motors and those who are responsible for their application as parts of machines will find this book thoroughly informative and beneficial In addition to the subjects in the foregoing, chapters discuss design, universal motors, commutation, insulation and insulating materials, testing and performance characteristics, etc. The text is supplemented by numerous illustrations.

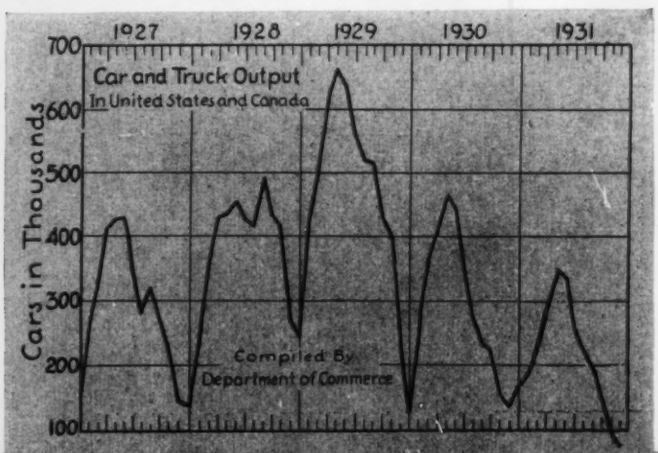


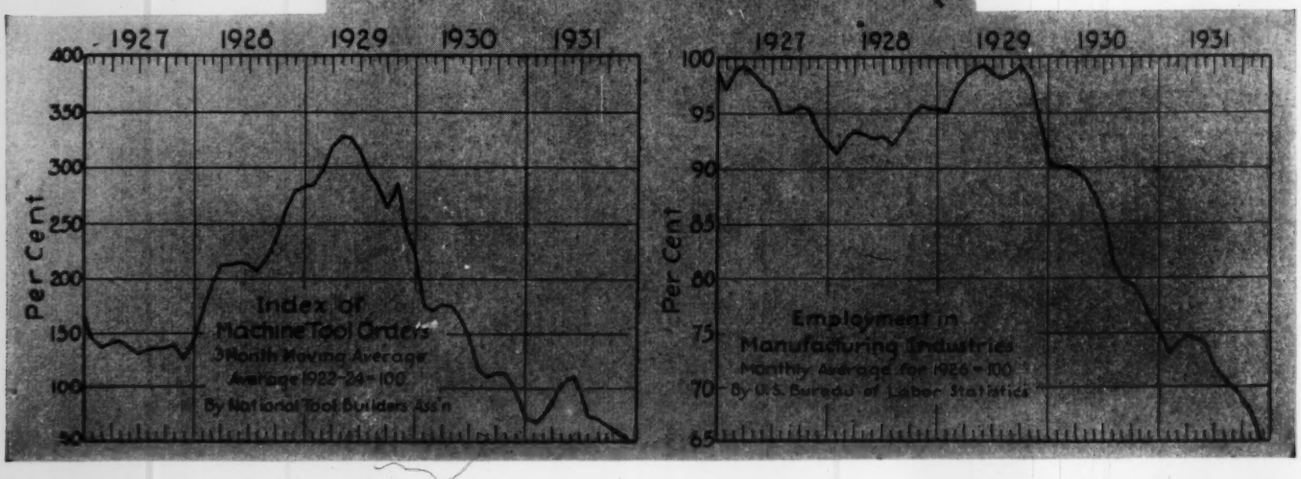
How Is Business?

CYCLES in business activity have proved, much to the regret of business in general, that they are unstoppable. All the ballyhoo possible to command, all the impetus of unprecedented business failed dismally to stop the present slump or to check it materially. Now the statistics of 50 years have been explored to add zest to the hypocritical sighs at the obsequies for 1931.

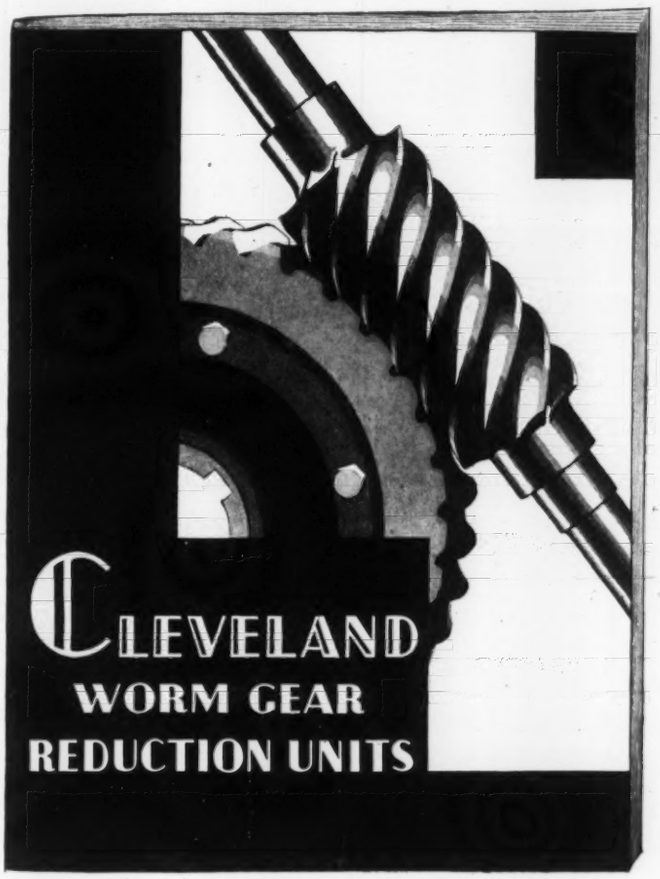
These data reveal that the one industry that may be taken as an accurate mirror of all others, the steel industry, has never experienced more than two successive years of decline no matter how serious were business conditions. And the two years for the present slide closed with 1931. Through the procedure followed by the steel industry of producing only enough steel to fill orders on hand, the index of steel production gives a remarkably reliable picture of automobile output, machine tool orders, industrial production and other basic information.

The decline has undoubtedly reduced its speed. Reductions during 1931 were considerably less than those experienced during 1930, in many cases being less than half. In practically all fields November touched a new low with little promise being advanced for any immediate upturn. However, the continued inactivity is adding to the pressure behind the dam; a pressure built up by obsolesence, replacement requirements, and improvement needs. This pressure must be relieved by the production of many new machines.





A BOOK planned especially for SPEED REDUCER BUYERS



IF YOU are a speed reducer user—if you are a speed reducer buyer—if you are a designer who must "lay in" speed reducer units—you will need a copy of this new Cleveland Bulletin.

Note the partial list of contents in the column to the left—recall the number of times these questions have come up in arriving at speed reducer decisions—and you will appreciate the importance of having this information at hand when you need it.

NO CHARGE is made for your copy, if you will request it on your letterhead, or the coupon below. Write today, and keep this valuable data on hand for future use.

CLEVELAND WORM GEARING • THE ULTIMATE DRIVE

THIS *new speed reducer book explains—*

Worm gear design
Power capacities
Horizontal drives
Drives for overhung loads
Double reduction drives
Vertical drives
Torque capacities
Bed plate mountings
Shaft extensions
Standard worms and gears
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NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

COMBINED electrical and mechanical devices are employed in a recently invented unit for sorting bodies of different weight, to which improvements have been added as outlined in patent No. 1,835,186. The original unit is covered by patent No. 1,770,810. Pancras Schoonenberg, Eindhoven, Netherlands, is the designer and the N. V. Philips' Gloeilampenfabrieken is assignee. In Fig. 1 is shown *A*, which is a front elevation; *B*, a side elevation; *C*, circuit arrangement for energization of the magnets; *D*, detail view of the carrier.

The device is designed for sorting such objects as glass rods or tubes which are fed one by one by the conveyor device 11 to the lever 10. Under the weight of the tubes this lever deflects with the result that the pointer 13 slides over the contacts 14-17. After the lever 10 has come to rest in a position on one of the contacts the switch 63 is closed by disk 65 and a corresponding solenoid is energized. The energization of the solenoid effects closing of a circuit through shunt 70 so that the current keeps passing through the solenoid of the magnet independently of the position occupied by pointer 13. The solenoid will be energized until switch 63 is opened as a result of movement of cam 65.

Carriers 24 are provided with V-shaped supports 25 in which the tube rests. As a result of the movement of the carriers 24 the tube is ejected from the lever 10 and carried on. By virtue of the weighing operation one of the magnets 34-37 is energized, and consequently one of the projecting lugs 30 is moved into the path of one of the tumble lugs 26 so that this latter is tilted and comes into a position which is determined by lug 29 (the position shown at D).

The tube is carried by the carrier relatively to the sorting units 40-43 and during this movement the plane protruding part 39 of lug 26 engages one of the lugs 50 so that lug 48 engages the counterpoise 46. Consequently the bell crank 44 is set tightly. Counterpoise 46 is so calculated that the bell crank 45 falls back under the weight of the tube when it has not been set tightly by lug 48. Otherwise the tube is lifted out of the V-shaped support and led along guideway 53-56 to one of the sorting chambers.

That period at which carriers 24 are allowed to pass over 10 is controlled entirely by the time in which the weighing device comes to rest after being loaded. By means of suitable damping mechanisms this length of time may be reduced to minimum values so that the period in which one carrier follows the other can be reduced to 3 to 4 seconds, which facilitates weighing and sorting about 15 articles per minute.

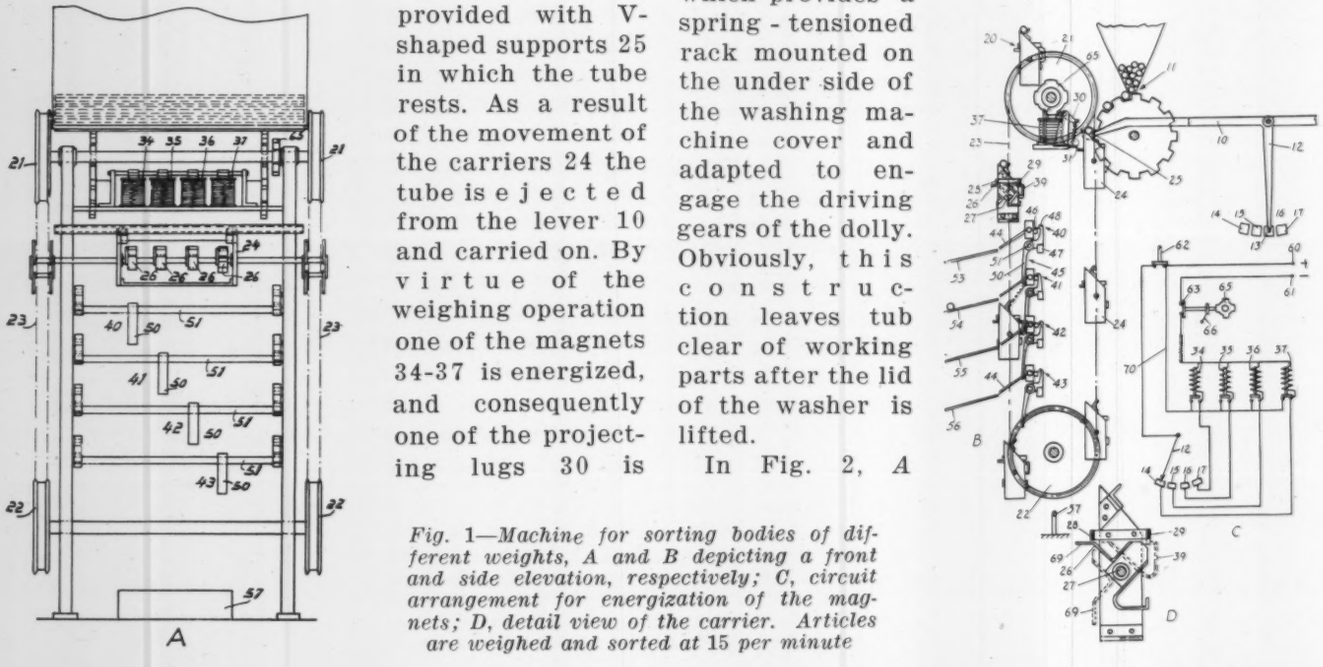
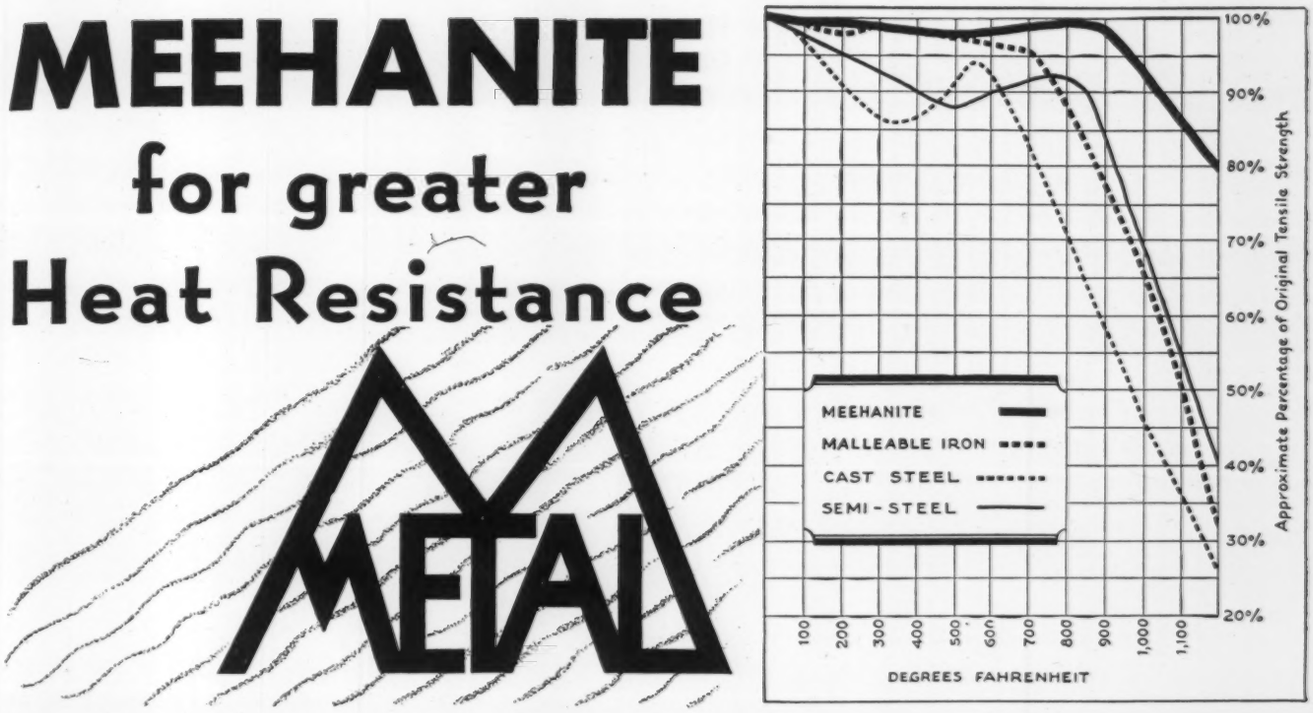


Fig. 1—Machine for sorting bodies of different weights, A and B depicting a front and side elevation, respectively; C, circuit arrangement for energization of the magnets; D, detail view of the carrier. Articles are weighed and sorted at 15 per minute

TYPIFYING a new trend in washing machine design a driving mechanism recently has been developed by John Nelson, Newton, Iowa, which provides a spring-tensioned rack mounted on the under side of the washing machine cover and adapted to engage the driving gears of the dolly. Obviously, this construction leaves tub clear of working parts after the lid of the washer is lifted.

In Fig. 2, *A*

MEEHANITE
for greater Heat Resistance



AN important use of Meehanite is in castings to resist the action of heat—castings which are non-growing and which will retain strength and stiffness at elevated temperatures.

The foundry process used for castings of this type is controlled to produce a metal with highly stabilized carbides and with graphitic carbon in small nodular form.

The chart shown here is plotted from results of carefully made tests to compare the strengths at various temperatures of Meehanite with semi-steel, cast steel and malleable iron.

A Few Typical Examples

IN a cement mill the clinker chute carries hot clinker directly from the kiln. Gray iron chutes in this service last three months, while Meehanite chutes are lasting over twelve months.

SUGAR retorts, both cast iron and Meehanite were placed in operation side by side. After the cast iron units had completely failed, being badly warped, burned through in spots and showing considerable growth, the Meehanite units were still in perfect condition. The service life of Meehanite Retorts is better than 2 to 1 compared with cast iron.

CAST iron annealing boxes with an average service life of 21 heats were replaced by Meehanite boxes which normally serve 110 heats.

THE installation of Meehanite stoker parts enabled a central station to double the output of its boilers and at the same time raise its furnace temperature 500 degrees.

Whenever you require greater service from castings subjected to high temperatures, get in touch with one of the Meehanite foundries for specific service information and costs.

MEEHANITE FOUNDRIES

ANSONIA, CONN.
Farrel Birmingham Co.
CHATTANOOGA, TENN.
Ross-Meehan Foundries
CHICAGO, ILL.
Greenlee Foundry Co.
CLEVELAND, OHIO
Fulton Foundry & Machine Co.
DETROIT, MICH.
Michigan Valve & Foundry Co.
INDIANAPOLIS, IND.
Indianapolis Casting Co.
MILWAUKEE, WIS.
National Equipment Corp.
PHILADELPHIA, PA.
H. W. Butterworth & Sons Co.
PITTSBURGH, PA.
Rosedale Foundry & Machine Co.
ST. LOUIS, MO.
Banner Iron Works
TRENTON, N. J.
Trenton Malleable Iron Works
TORONTO, ONT.
Dodge Manufacturing Co.
TORONTO, ONT.
Jessop Steel Company

MEEHANITE INSTITUTE

Meehanite Patents: U. S. Patent Nos: 1,499,068 · 1,683,087 · 1,683,086 · 1,731,346. Canadian Patent Nos: 234,933 · 287,903 · 304,254. Other patents pending.

shows the lid raised, and *B*, the driving mechanism for the dolly. Referring to *B* for details of the gear drive, it will be seen that an intermediate gear 56 is pivoted by the bearing 57 secured in the lid 58. This intermediate gear is adapted to mesh with the rack, driving the

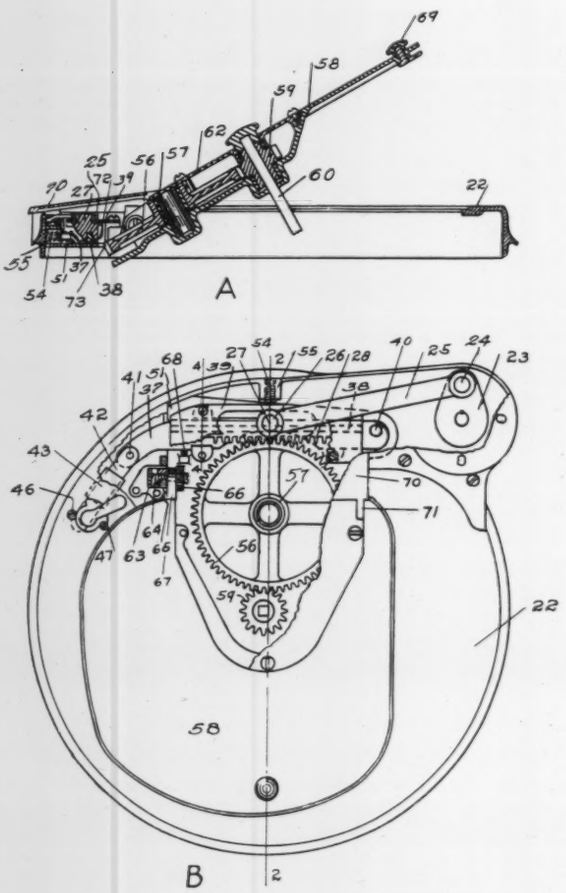


Fig. 2—Driving arrangement for washing machine mounted on the underside of the cover. A, lid raised; B, the mechanism

pinion 59 which in turn drives the dolly. To facilitate location of the intermediate gear 56 in the same plane as the rack bar, the lid is cast in such a manner that a supplemental cover or lid must necessarily be screwed on in order that the upper side of the lid may be flat. The lid 58 as shown in *A* does not comprise the entire top of the washer, the tub being partly covered by the overlying edges of cover 22.

A spring-tensioned relationship between the rack and intermediate gear to permit a quietly running driving mechanism is provided by the use of the coil spring 54 which applies tension upon the frame portion to hold the frame and rack in engagement with the intermediate gear. The spring-tensioned arrangement of the rack and the beveling of adjacent gear teeth both on the rack and intermediate gear prevents breakage due to raising or lowering of the lid while the rack is in engagement with the intermediate gear. The patent number is 1,834,133 and Automatic Washer Co., Newton, Iowa, is assignee.

CONVERSION of reciprocating motion into circular motion is affected by a reversible device recently patented by Adolphe L. Varcin, of Lens, France. In outlining his patent he states that the mechanism may be used for converting the rectangular reciprocating motion of a piston in an engine cylinder into circular motion, or for converting the circular motion of a driving pinion into a straight motion to reciprocate a piston pump. Number of the patent is 1,835,680.

Fig. 3 shows piston E at the power stroke and moving to its lower dead center. Pinions P_1 and P_2 and racks 1 and 2 are out of gear, rollers G_1, G_2 rolling respectively upon the upper and lower faces of cam-shaped boss 20. Due to the momentum of segment gears P_1 and P_2 and gear wheels 12 and 13 which are rotating in the direction of arrow A, cam T tends to rotate in the reverse direction. Moreover, because of the concave shape of the upper face or track of boss 20, the pressure transmitted from piston E through bracket S and roller G_1 to boss 20 has a tangential component which also tends to rotate cam T in the direction contrary to arrow A.

By rotation of cam T under the pressure which is exercised successively by controllers G_1 and G_2, gear wheel 14 drives gear 13 in a continuous manner in the direction of arrow A until the forward teeth of segment gear P_2 engage the upper teeth of rack 2. From this instant, segment gear P_2 is driven directly by rack 2 until piston E reaches its upper dead center. Simultaneously, cam T is rotated by gear wheels

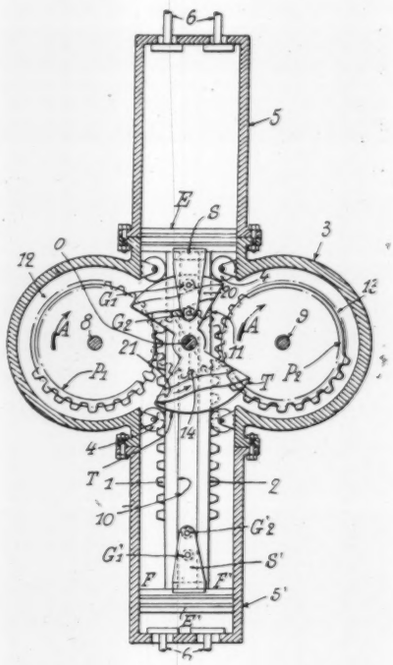
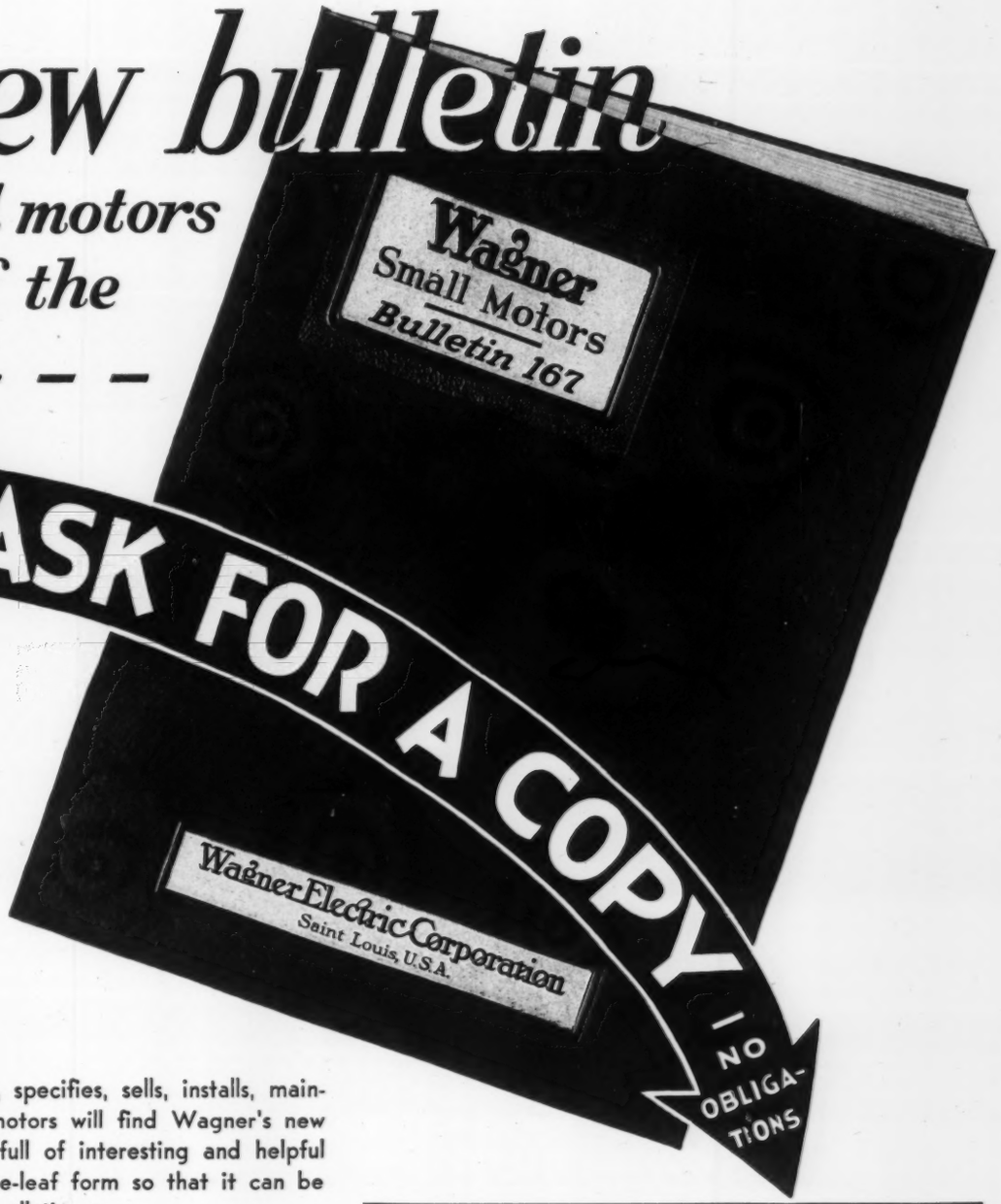


Fig. 3—Device for converting reciprocating motion into circular motion or vice versa. Piston E is shown at the power stroke and moving to its lower dead center with cam T rotating in a direction contrary to arrow A

13 and 14 and the right hand end of boss 20 leaves rollers G_1 and G_2. Slightly before a complete revolution is performed boss 21 engages between rollers G'_1 and G'_2 which are near the upper limit of their stroke, and segment gear P_2 ceases to mesh with rack 2.

A new bulletin

on small motors just off the press - - -



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Everyone who buys, uses, specifies, sells, installs, maintains and repairs small motors will find Wagner's new bulletin on small motors full of interesting and helpful information. It is in loose-leaf form so that it can be kept up to the minute at all times.

At the present time the bulletin consists of thirty pages —22 on single-phase repulsion-start-induction motors, and 8 on single-phase split-phase motors. Additional pages on polyphase squirrel-cage, single-phase condenser, and direct-current motors will be available in the near future.

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S431-7XA

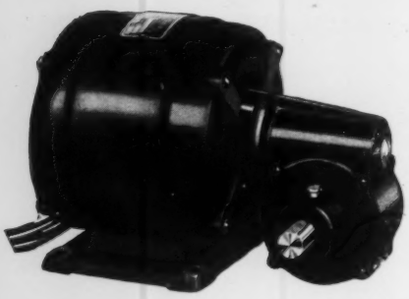
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Motors Have Built-in Speed Reducers

FRACTIONAL horsepower motors with built-in worm gear speed reducers have been added to the line of motors manufactured by Bodine Electric Co., 2264 West Ohio street, Chicago. These motors are embodied in the new type N-5 frame, which is of three-piece construction. The ventilating ducts and fan have been enlarged and ratings increased.

Gear reductions of the motors, shown herewith, are available in 10:1, 20:1 and 40:1 ratios, which afford slow shaft speeds of 28, 43, 56, 86, 112, and 172 revolutions per minute at standard motor speeds of 1125 and 1725. The speed reducer consists of a separable nitralloy steel worm and an oversize Bakelite gear, mounted in a grease-tight housing forming an integral part of the end shield of the motor.



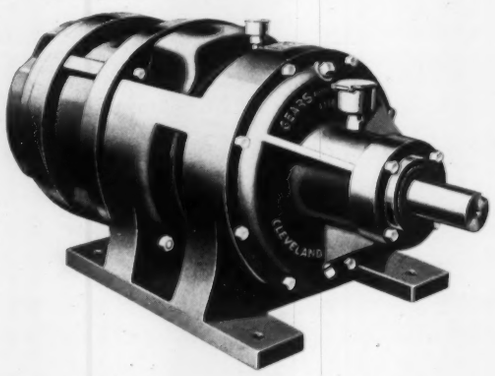
Fractional horsepower motors have built-in worm gear speed reducers which afford speeds on the slow shaft of from 28 to 172 revolutions per minute

Double ball bearings absorb end thrust on the rotor shaft and preserve alignment of the gears. The bearings are packed in grease at the factory and require no further attention. The slow speed shaft runs in leaded bronze bearings with wool-packed lubrication. These motors are rated from 1/20 to ⅛ horsepower and are available in alternating and direct current models.

Motorizes Planetary Speed Reducers

WITH a speed reducer of the planetary type and an electric motor built into an integral unit, Gears & Forgings Inc., Cleveland, has developed a motorized speed reducer which makes a single, neat and compact unit. This self-powered and self-contained type of speed reducer, shown herewith, is designed particularly for applications where available space for the driving mechanism is limited.

The housing of the reduction gears is dust proof and oil tight. It is integral with the base which extends to the center line of motor and also provides rigid support to gearing and output shaft which carries the load. No additional loads are imposed on the motor shaft which is supported by two ball bearings. These motorized speed reducers are made in 34 standard ratios ranging from 4:1 to 240:1 inclusive, and in sizes from ¼ to 30 horsepower.



Motor and speed reducer are combined as an integral unit in a dust proof and oil tight housing

Gasket Material Is Moisture Proof

MOISTURE proof and highly oil resistant, a new gasket material, announced by General Electric Co., Schenectady, N. Y., is recommended especially for applications where the primary purpose of the gasket is to exclude moisture, for which purpose it has been found unusually efficient. The new material, known as No. 1000, is a white, odorless, sulphur-free rubber compound, available both in sheets and molded shapes.

It is extremely tough and strong, flexible, requires no sticker, and can be used repeatedly in testing work as well as in permanent joints. It is unaffected by exposure to the weather, and

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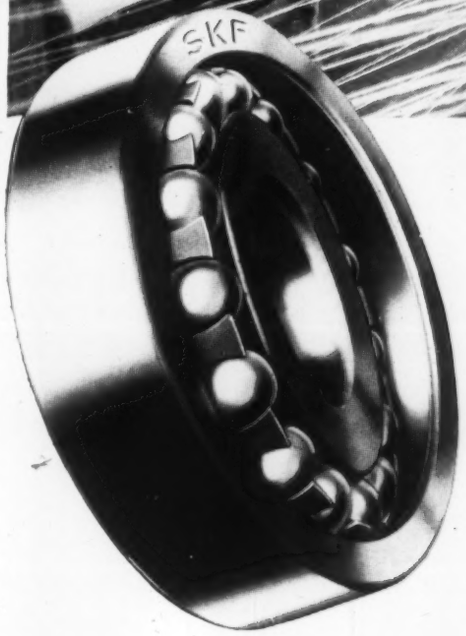
Kitson Picker equipped with SKF bearings and made by Saco-Lowell Company of Boston, Massachusetts... for years users of SKF Bearings on all types of textile machinery.



industries that depend upon uninterrupted production schedules depend upon SKF ... *all* industries.

The mark SKF on a bearing means something more than mere commercial patter on the subject of quality. It means that the bearing was designed for the job . . . laboratory-tested for the job . . . manufactured *up* to the demands to be made upon it, not *down* to a price that someone might be willing to pay for it . . .

SKF is a world product. Wheels turn on SKF in every country on the globe. There's no place under the sun of the civilized world where you can't get SKF replacements, SKF service. And *that* to the manufacturer of an SKF equipped product means something too.

More than fifty leading manufacturers of textile machinery equip their products with SKF Bearings.

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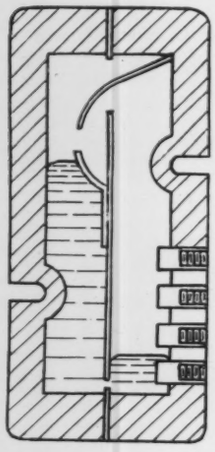
2785

when under compression in properly made joints is not attacked by cold oil. In contact with hot oil, the material practically is unaffected where enclosed in recessed joints under compression, but generally is not recommended where resistance to hot oil is of prime importance. Mildly alkaline solutions, such as derived from Portland cement, or dilute acid solutions have no apparent effect on the material.

Announces Unique Time Delay Switch

UNAFFECTED by temperature changes or operating conditions, the new time delay switch, developed by Lincoln Electric Co., Cleveland, operates much like an hour glass since its principle is the slow movement of mercury from one chamber to another. When the switch is in the off position, it is tilted to the left and the mercury is in the lower chamber.



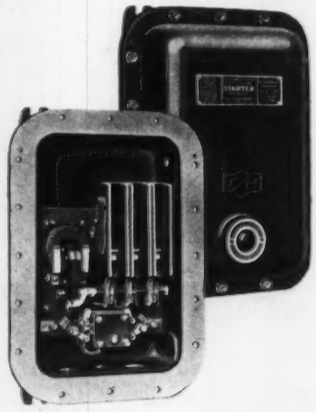
Time delay switch beginning contact. When the switch is tilted to the position shown, mercury flows through the lower opening

Wire connections are tapped to the upper compartment. In the illustration, the switch has been turned and the mercury has begun to flow into the upper cavity through a small opening. As this mercury rises it completes the circuit at the various taps. By changing one connection to the different taps a variation in time delay is secured in each switch. By varying the size of the small opening at the bottom the switch can be manufactured to give the time delay desired.

When the switch is turned off, that is, when it resumes its horizontal position, the mercury passes through a large opening, shown at the top center, into the lower chamber and the switch is ready to be used again as contact is broken immediately. This type of switch can be built for an accurate time delay of 2 to 20 seconds.

Designs Explosion Proof Starters

AUTOMATIC starters of the explosion proof. across-the-line type, designed in accordance with the specifications of the Underwriters laboratories for class I, group D hazardous locations, are being manufactured by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. These specifications include applications where explosive gas or dust is prevalent in the atmosphere. This new starter, shown herewith, is of the air break type—all contacts are made and broken in air—there is no oil tank. The heavy cast iron, explosion proof enclosure is designed to prevent any explosion which might occur within from igniting the surrounding explosive atmosphere.



For use in explosive atmosphere there has been developed these across-the-line automatic starters

The construction of the starter proper consists of a standard 3-pole magnetic contactor with thermal overload relays to protect the motor from burnout due to overloads. The enclosing case is of the "split" type, which, when opened, allows easy access to all parts of the starter. Extra wide and accurately machined flanges are provided between the cover and case. These starters are designed in three sizes, to take care of motors up to 30 horsepower, 220 volts; and 50 horsepower, 440 or 550 volts.

Reduction Units Supplement Line

DESIGNED to transmit up to about 7½ horsepower, the capacity depending upon the reduction ratio and worm speed, the new series of worm gear reduction units introduced by Cleveland Worm and Gear Co., 3258 East Eightieth street, Cleveland, supplements the standard units manufactured by the company. The new size unit is furnished in both horizontal and vertical types and is designated size 70. Horizontal units are built with the worm below or above the gear while in the vertical type the gear shaft may extend upward or downward. The accompanying illustration shows the horizontal type.

All shafts in the new series are mounted in antifriction bearings, the gear shaft mounting of the vertical type being such that the unit will withstand an external axial thrust downward of 2000 pounds. The worm and its shaft are made from a single nickel alloy steel forging, carburized, heat treated, hardened and ground all over to high degree of accuracy. The gear is hobbed

A *ROLLING* Path for Power Stays Young

This Diamond Drive outlasted three drives of another type under identical unfavorable conditions—7½ H. P. motor at 1750 R. P. M.

AGE is a question of wear, and rolling surfaces "shed" wear. Why not apply these self-evident and accepted principles to that vital part of production—transmission?

Diamond Drives incorporate the roller bearing principle—rolling at all points of contact. Consequently, they stay young—keep that first efficiency and speed throughout their long life. Naturally, maintenance is less.

Diamond Drives are flexible—driving efficiently on short centers or long, either *over* or *under* any number of sprockets. They are lighter for given capacities—more compact—quiet—and approach perfection for any drive up to 3600 R. P. M. and 672 H. P.

The performance of Diamond Roller Chain Drives in 112 major divisions of American Industry is proof you can well accept—and make the right start toward solving your drive problems.

The Booklet 102-B *"Reducing the Cost of Power Transmission"* fully describes this rolling path for power which stays young. Mail the coupon.

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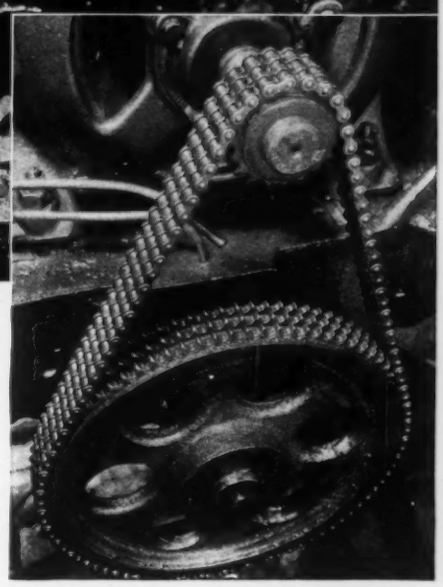

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Practically all your transmission needs can be met with Diamond Drives from stock. A nearby Diamond Distributor can supply you immediately motor drives ranging from ¼ to 75 h. p., 600 to 1800 r. p. m., 1/1 to 8.4/1 ratios. Furthermore, the Stock Drive makes selection and ordering a matter of minutes.

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(A-4157)

from a solid chill-cast, nickel-bronze blank. Worm thread is of the automotive type with high pressure angle.

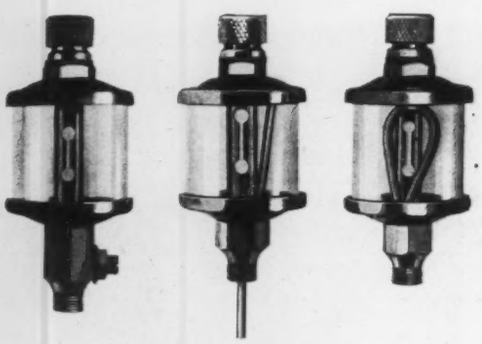
The housing of the reduction unit is exceptionally sturdy with heavy walls, internal ribs,

All shafts on new series of worm gear reduction unit are mounted on anti-friction bearings

and bolt flanges. All bolt holes are spot faced and the clamping plates are all finished under the bolt heads. Oil seals are fitted on each shaft extension. Standard keys are furnished with each reducer. Nine standard ratios, varying from 4-5/16:1 to 60:1 and fifteen special ratios are available.

Air Expansion Operates Lubricators

LUBRICATORS which operate according to the simple laws of nature, the expansion and contraction of air caused by a change of temperature, are a recent development of Victor Lubricator Co., 3900 North Rockwell street, Chicago. This device, shown herewith, is of air



Expansion and contraction of air as affected by the bearing temperature operates these lubricators

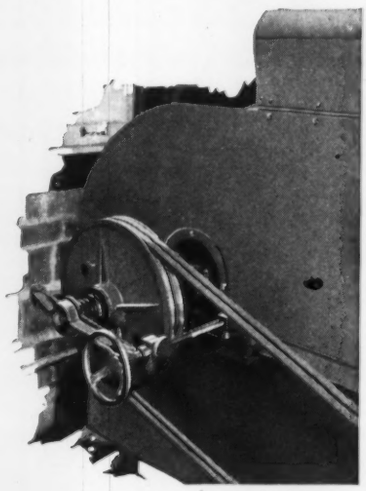
tight construction. After putting oil in the lubricator, filling it about three-quarters full, the cap is screwed down tightly completing the air seal and leaving an air space above the oil.

Any slight increase in the temperature of the oil film around the bearing is transmitted to the air space in the lubricator causing the air to expand. As the lubricator is air tight, this expansion causes the development of pressure on the body of oil and automatically forces the required amount of oil to the bearing. A resulting decrease in temperature of oil film around the bearing is in turn transmitted to the air space causing the air to contract, automatically stopping the flow of oil. The air supply is replenished automatically, air being drawn through the base of the lubricator to replace oil which is fed out.

These lubricators do not work on the thermostatic principle and they do not operate from "heat" or at any predetermined temperature. They operate from a slight change in temperature and regardless of whether the slight increase or decrease is from a low temperature or from a high temperature.

Unit Provides Variable Speeds

MOUNTED on the driven shaft, the new I. V. S. variable speed unit, marketed by Smith Power Transmission Co., 434 Penton

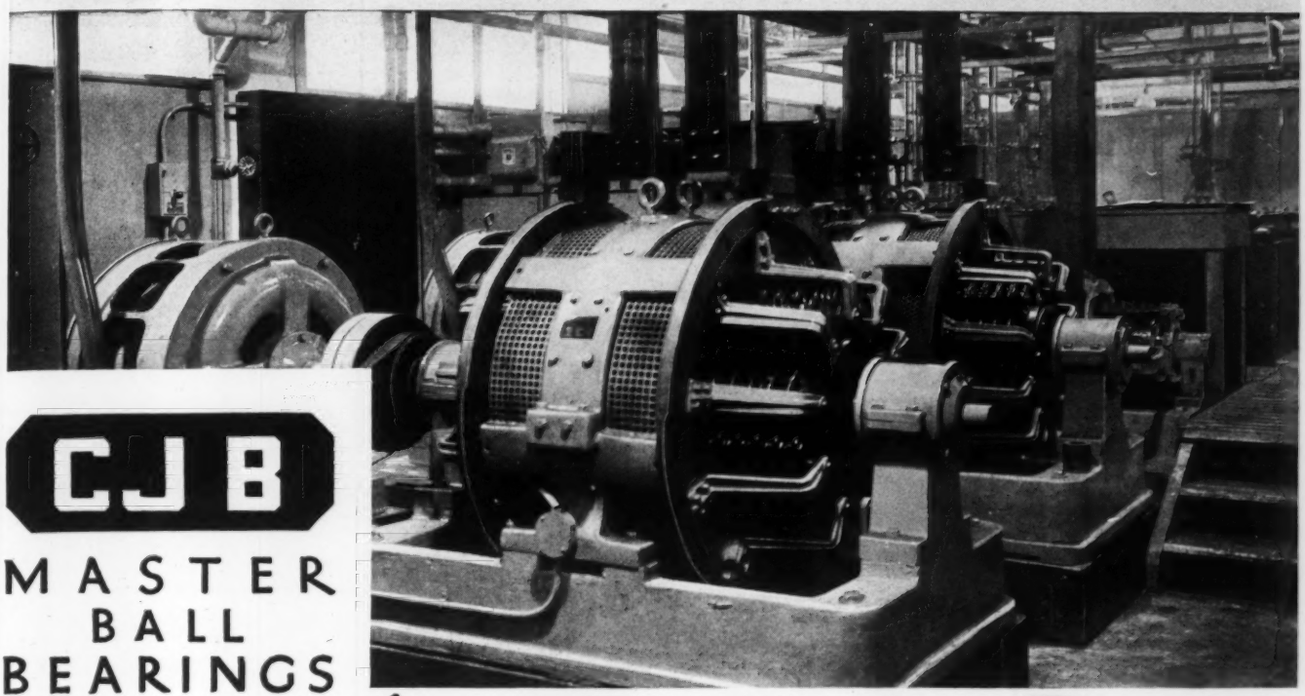


Centrifugal force acting through swinging weights controls shaft speeds through this variable speed unit which may be set for an infinite number of speeds within the range of the unit

building, Cleveland, can be adjusted from zero to a maximum speed for a set ratio by turning a handwheel or screw. Ratios can be obtained as high as nine to one. The unit is so constructed that it can be used as the driven pulley for flat belt, driven sprocket or silent or roller chain or driven sheave for V-belts. It is shock absorbing and does not exert any additional bearing loads. In mounting, no special supports, bases or foundations are needed. Units are now available up to five horsepower.

One part of the unit, shown herewith, is keyed to the shaft to be driven, while the other portion is driven by the chain or belt. Increasing the pressure on the spring, shown at the side, brings a friction facing on one part to bear

ON THE FRONTIER OF MACHINE DESIGN . . .



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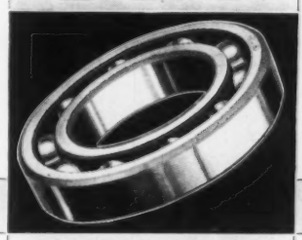

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Greetings

The Leland Electric Company files no complaint regarding 1931 business. While there was, to be sure, room for improvement, the general level for the year was substantially above that enjoyed by business in general.

The Leland Company enters the new year with confidence. The line has been enlarged. The product has been still further improved. There is every reason to forecast 1932 as a good Leland year.

May we express the hope, and the belief, that your business—all business—will be better during the twelve months that lie just ahead, that 1932 will be very satisfactory for all industry.

We extend to you our very best wishes.

BEST WISHES FOR THE NEW YEAR 1932

BEST WISHES FOR THE NEW YEAR 1932

The Leland Electric Co.
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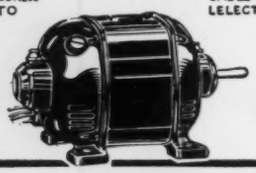
CABLE ADDRESS LELECT-DAYTON



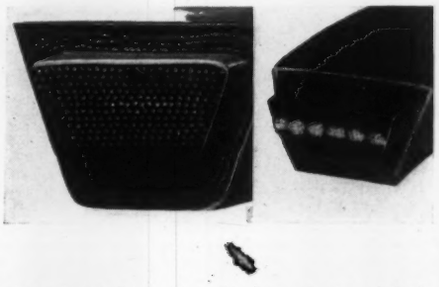
Leland Motors

against the other and the shaft is driven. On the inside of the unit there are free-swinging weights, which when the speed of the shaft and the consequent centrifugal force reaches a predetermined amount are moved outwardly, and, through inclined cams, separate the two portions of the unit, stopping the driving action. As soon as the speed drops below the set amount, the spring forces the friction faces back into contact.

Spring pressure can be set to any amount giving an infinite number of speeds at which the mechanism will drive. The centrifugal force acts instantly at the upper limit and the spring gives positive action as soon as the speed drops. The action on the driven shaft consists of practically a constant speed drive.

V-Belts Are of New Construction

DEPARTING from the practice of one general construction for all sizes of V-belts, Manhattan Rubber Mfg. division of Raybestos-Manhattan Inc., Passaic, N. J., has developed belts



Cross sections of two types of V-belt which are made up in an entirely new manner

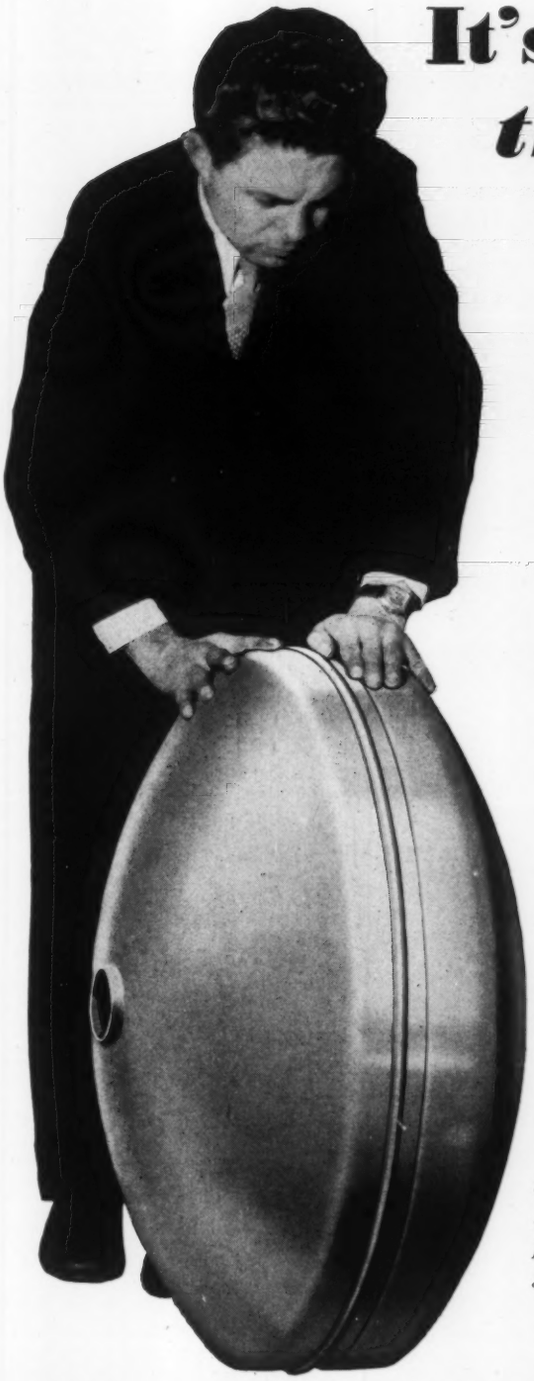
with no inelastic stretch. In light duty high speed sizes, a strong, flexible "Whipcord" construction is used and, for heavy duty service, a more rugged design known as "Plycord."

Whipcord, in detail, consists of one layer of continuously wound cords embedded between two layers of tie-gum. The balance of the belt is filled out with the right proportions of extensible and compressible rubber with a closely woven rubberized duck cover to complete the structure.

Plycord is made up of continuously wound plies of cord with one layer of tie-gum between each. When built up to right thickness and correct number of plies, it is cut to the correct angle of the belt. The balance of the construction is similar to Whipcord.

Organizes Noise Elimination Service

ORGANIZED specifically for the solution of noise problems, a new consulting service has been established by Maxim Silencer Co., Hartford, Conn., as an addition to the regular



It's Easier to Subtract *than to* Add . . *and the* Result *is the* Same

IF you could add 3 to 10% to selling price it would be fine for profits. But what would customers think and do? Subtract, then, from production costs . . . and you have the same chance to earn a profit.

Many manufacturers are letting G. P. & F. help them make subtraction do the same thing as addition. The shell drawn from stainless steel shown, is an example of what can be done.

The use of G. P. & F. stampings cuts material and finishing costs . . . and eliminates machining costs entirely. Better still, it adds sales appeal . . . lighter weight, increased convenience, durable modern finishes, and beauty of design.

G. P. & F. has 50 Years' Experience

More than half a century of experience . . . an ever-growing clientele including many of the largest manufacturers of the country are guarantees that G. P. & F. engineering and design service is almost certain to boost your profits. A few moments of your time is the only cost of finding out what G. P. & F. stampings will do for your profits and your product. Just send a sample or drawing and let us recommend. No obligation whatever.

Drawn from Stainless Steel

Shell drawn by G.P.&F. from 16-gauge stainless steel. Two parts of shell are welded together after assembly.

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SPECIALIZED BRONZE PARTS

SCIENTIFICALLY MADE

THE new and greater use of bronze alloys for bushings, bearings, gears and an almost infinite variety of other mechanical parts is solving production and profit problems for a fast-increasing number of machinery manufacturers.

¶ Our vast experience and constant research work in collaboration with the U. S. Bureau of Standards enable us to advise you accurately on alloy, design and lubrication of special bronze bearings or parts.

¶ Lubrication of any bearing by means of proper oil-grooving is scientifically achieved here without excessive cost or loss of bearing area. Oil-grooving is an intricate detail of bearing specification that cannot be properly achieved without the specialized knowledge and equipment which we possess.

Our expert engineering counsel on specifications costs you nothing. You are in no way committed or obligated. Let us help you reduce your cost and improve your product.

Bronze Bushings » Bronze Washers » Bronze-Backed Babbitt-Lined Bearings » Super-Hard Bronze Bushings » Graphited-Bronze Bearings » Bronze parts of various designs and alloys » Bronze Castings rough or finished » Bronze and Lead Hammers » Anti-Friction Babbitt » Cored and Solid Bronze Bars » 500 sizes of standard finished bushings always in stock.

THE BUNTING BRASS & BRONZE CO.
TOLEDO, OHIO

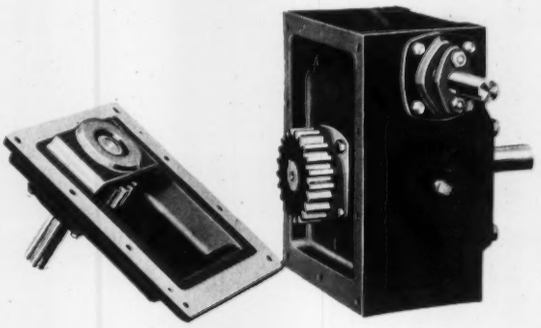
Branches and Warehouses at: New York, Chicago, Boston, Detroit, Cleveland, Philadelphia, Seattle, San Francisco Export Office, Toledo, Ohio

BUNTING
QUALITY
PHOSPHOR BRONZE
BUSHING
BEARINGS

line of business of the company. The service will be headed by Dr. Hiram Percy Maxim, the inventor of the Maxim Silencer, and will have at its disposal the services of the entire engineering and research staffs of the company.

Reversing Unit Is Adaptable

ALL gear teeth are permanently in mesh in the new type of two-speed reversing unit designed by Ohio Gear Co., 1333 East 179th street Cleveland, thus avoiding undue wear. When used as a substitute for bevel gear reverse,



All gear teeth are permanently in mesh in new type of two-speed reducing unit

the unit, shown herewith, permits the clutch to be placed where most convenient, instead of necessarily between the two ends of the shafts where, as a rule, there is little room to spare.

The two speeds may be arranged for 1:1 ratio or any other reasonable ratio likely to be required. Furthermore, the shafts may be arranged to be on opposite sides of the housing or on the same side and to operate in the same or in opposite directions as may be specified.

The unit can be arranged to operate shafts whose centers are several inches apart. If a Hookes joint or similar device is added, it can operate shafts which are out of line as well as out of center. Being completely enclosed, the unit is dust and moisture proof; and the grease lubricated bearings assure efficient operation over long periods without attention.

New Brakes Are Smooth Setting

SHOE-TYPE, weatherproof Thrustor-operated brakes for alternating current motors on mill, crane, hoist and similar applications where severe service requirements must be met are the latest development of General Electric Co., Schenectady, N. Y. These brakes, shown herewith, provide quick, cushion-like braking in either direction of rotation with either light or heavy

Photo by
Ewing Galloway

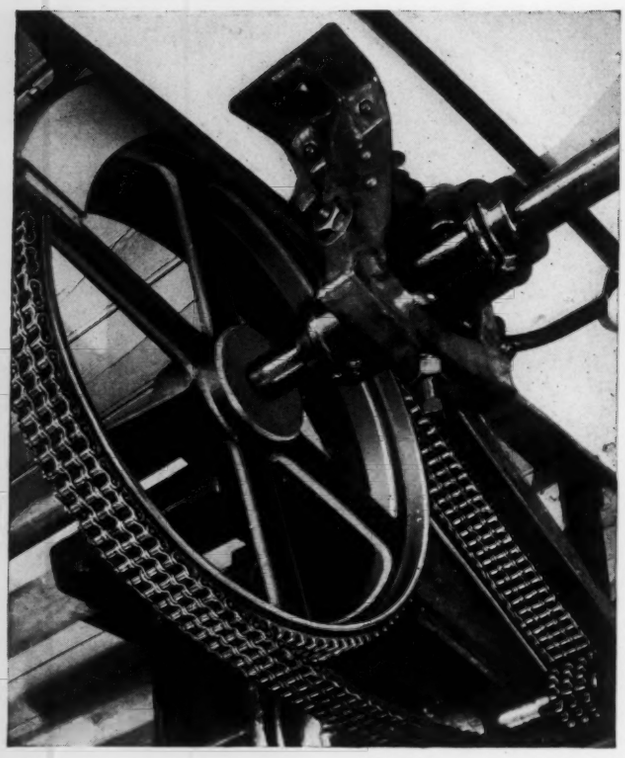
THE life of machinery subject to excessive wear and abrasion may, in many cases, be more than doubled by the addition of a small amount of nickel, chromium or manganese to simple carbon iron and steel.

The slight increase in the cost of alloy steel or iron is saved many times over in lower operating costs.

Our Metallurgical Engineers will be pleased to furnish further information on this subject and explain in what way ferro alloys may be used for your particular problem.

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide UCC *and Carbon Corporation*
Carbide and Carbon Building, 30 East 42nd Street
New York, N.Y.

Electromet
Ferro-Alloys & Metals



THIS DRIVE RAISES EFFICIENCY

A Duckworth Compound Roller Chain forms a line shaft drive that is as positive as a gear, and as elastic as a belt, and surprisingly light and quiet. It will operate efficiently at much higher speeds and on much shorter centers than is possible with single strand roller chains.

Duckworth Chains are available in a full range of sizes and types for all purposes of power transmission or material conveying. Our engineers will gladly make recommendations.

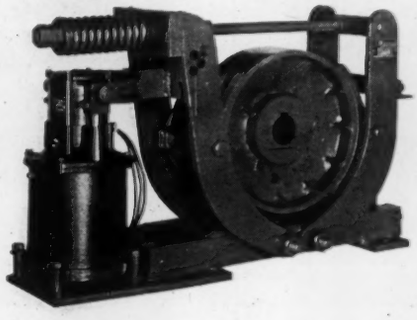
This new general catalog gives complete engineering and installation data. Send for a copy today.

BALDWIN-DUCKWORTH CHAIN CORPORATION
Baldwin Division, Worcester, Mass.
Duckworth Division, Springfield, Mass.

BALDWIN DUCKWORTH

loads, and are adjustable for braking over a wide range.

The characteristics of the Thrustor, described in the October issue of MACHINE DESIGN, make it particularly well adapted as an operating



Quick cushion-like braking is provided for severe service requirements

medium. It operates well within the time required to release and set a brake satisfactorily. In a fraction of the time required for the device to move through its complete stroke, the motor comes to full speed and the speed of thrust remains constant during the remainder of the stroke. The uniform speed characteristic also results in a smooth, cushion-like setting when the brake is de-energized. The use of the Thrustor minimizes braking mechanism inertia, shock and noise.

Develops Improved Starting Switches

EXPLOSION proof across-the-line starting switches of both the oil immersed and air break types are a recent development of Allen-Bradley Co., 1311 South First street, Milwaukee. These switches are used with squirrel cage motors and slip ring motors, on 3-phase or 2-phase 3-wire systems, as well as self-starting single phase motors, in oil refineries, chemical plants, mines and wherever flammable gases or vapors are liable to be present. The maximum ratings are 25 horsepower at 110 volts,

Starting switches for use with squirrel cage motors and slip ring motors on 3-phase or 2-phase three-wire systems are explosion proof

50 horsepower at 220 volts, and 100 horsepower at 440-550 volts. When used with slip ring mo-

POUGHKEEPSIE PLANT · THE FEDERAL BEARINGS CO., *Inc.*

. . . . THE FINEST BALL BEARINGS ARE MADE IN THIS GREAT PLANT. . . .

QUALITY in materials and precision in manufacture . . . . These are the characteristics which distinguish Federal Ball Bearings. The interlocking ball retainer is an *exclusive* feature which adds much to the efficiency of «Federals.» For many years, the manufacturers of America's leading cars have selected these bearings because of splendid performance and absolute dependability.

THE FEDERAL BEARING COMPANY, INC.
Poughkeepsie, N. Y.

associated with
The Schatz Manufacturing Company, Poughkeepsie, N. Y.,
Manufacturers of Commercial Annular Ball Bearings.

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BALL BEARINGS

SAVE ON YOUR MOLDED PARTS—THE Auburn WAY

Here's an Instance—

where Auburn Engineers were able to help a certain manufacturer make a considerable saving on finishing and assembling costs and at the same time make a more convenient and beautiful appearing product.

This twenty outlet panel for curling machines is molded of beautiful Bakelite in ONE PIECE. Note the extremely intricate design of the back. Forty-three brass connection inserts are molded right in the plate at three different depths.

Analyze your product! — what are the physical characteristics needed in each component part? They can invariably be molded of celluloid or phenolic compound parts of equal or better advantage than the material you are now using—and for less cost.

Give Auburn Engineers a chance to consider your "cut cost" problems.

Write us today.

Celluloid-Bakelite Division

Auburn Button Works, Inc.

Auburn, N. Y.

Auburn

Since 1876

Molders of CELLULOID and PHENOLIC COMPOUND PARTS

also LUMARITH, CELLULOSE ACETATE, ALDUR.

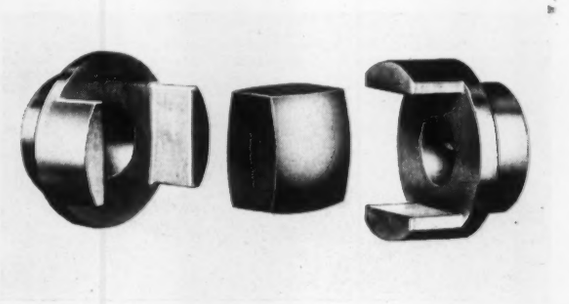
tors the switches are for primary control only.

The oil-immersed switches are available with ratings of 50, 100 and 150 amperes. The oil tank maintains at least a 6-inch head of oil above the switch panel. An air-break type of switch is available only in the 50 ampere size. It is enclosed in a cast iron cabinet with hinged cover, machined to obtain a tight fit without gaskets. The cabinet is cadmium plated to resist corrosion.

All switches have two magnetic overload relays, and the contactors are equipped with copper-to-copper rolling-type contacts as well as magnetic blowouts and arc shields.

Small Coupling Design Is Simple

SHAFT couplings with minimum bores of ¾ and 1 inch have been added to the line of flexible couplings manufactured by American Flexible Coupling Co., Erie, Pa. In general design and kinematic action, the small couplings, shown herewith, are the same as the larger couplings manufactured by the company.

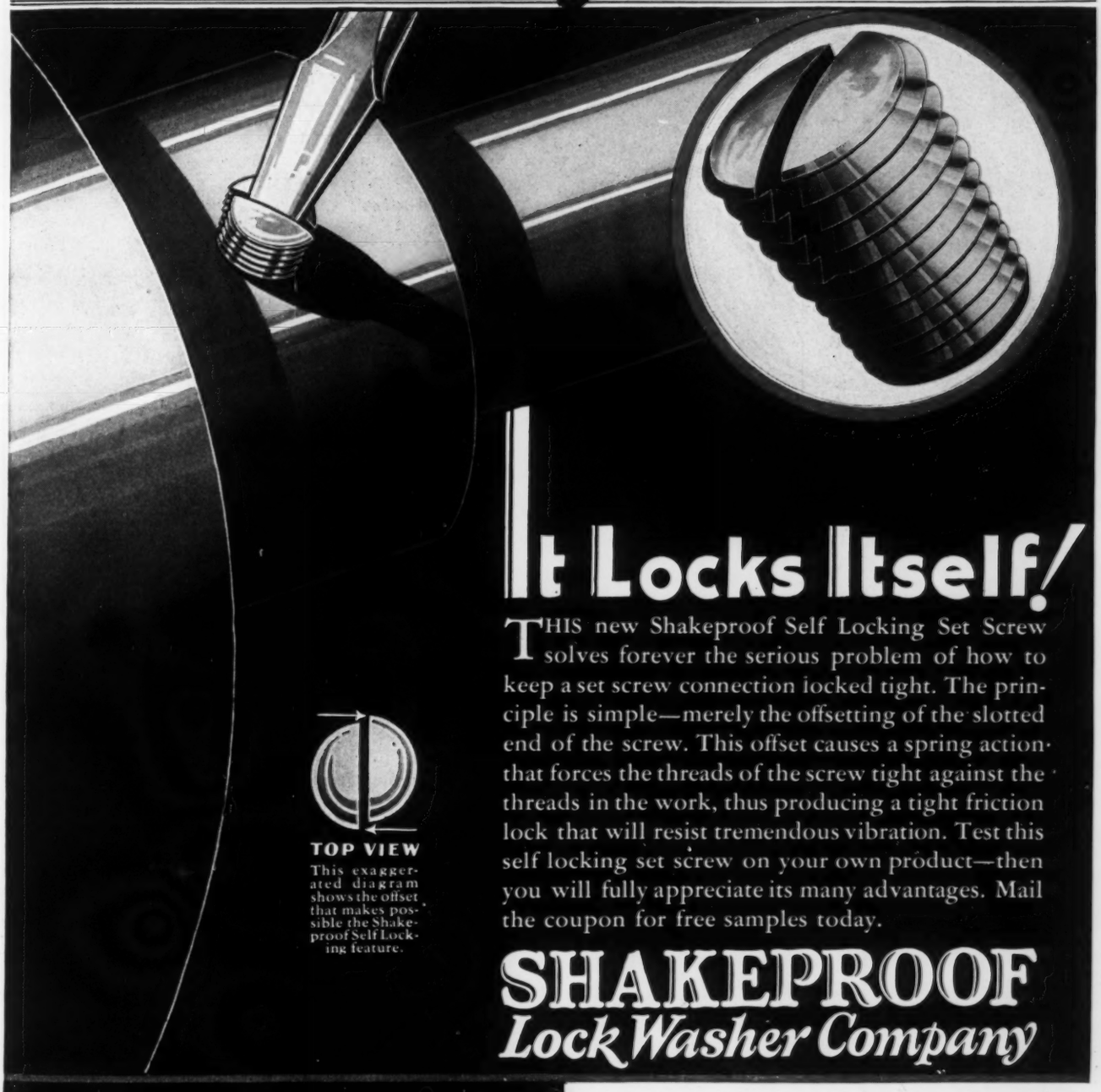


Floating member of small size couplings is a solid nonmetallic self-lubricating piece

Flange sections of the small units are die cast. A wide groove is formed in the face, leaving two jaws between which the floating center member slides. The floating member is a solid, nonmetallic, self-lubricating piece and transmits the torque between the flange sections. The design is simple and the coupling permits comparatively large misalignment between shafts without the use of springs, bolts, pins or flexible materials.

Power capacity is 0.05 horsepower per 100 revolutions per minute for the ¾-inch size and 0.15 horsepower per 100 revolutions for the 1-inch size. Both sizes permit a maximum parallel misalignment of 1/64-inch and a maximum angular misalignment of 1 degree. The standard flanges are provided with a single set screw, but additional screw or keyways can be provided. As in the larger sizes, it is not necessary to dismantle the coupling in order to disconnect the driving and driven shafts.

SHAKEPROOF
Self Locking Set Screw



TOP VIEW

This exaggerated diagram shows the offset that makes possible the Shakeproof Self Locking feature.

It Locks Itself!

THIS new Shakeproof Self Locking Set Screw solves forever the serious problem of how to keep a set screw connection locked tight. The principle is simple—merely the offsetting of the slotted end of the screw. This offset causes a spring action that forces the threads of the screw tight against the threads in the work, thus producing a tight friction lock that will resist tremendous vibration. Test this self locking set screw on your own product—then you will fully appreciate its many advantages. Mail the coupon for free samples today.

SHAKEPROOF
Lock Washer Company

Shakeproof representatives are located in the following cities:

New York City Philadelphia, Boston Pittsburgh Schenectady Cleveland Detroit Toledo Cincinnati Milwaukee Los Angeles Birmingham, Ala. Seattle Dallas, Texas San Francisco Toronto, Ontario, Canada

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COUPON

SHAKEPROOF LOCK WASHER CO.
(Division of Illinois Tool Works), 2551 N. Keeler Ave., Chicago, Ill.

Gentlemen: We want to test your new Self Locking Set Screw. Please send us samples as indicated.

Style of Point..... *Size*.....

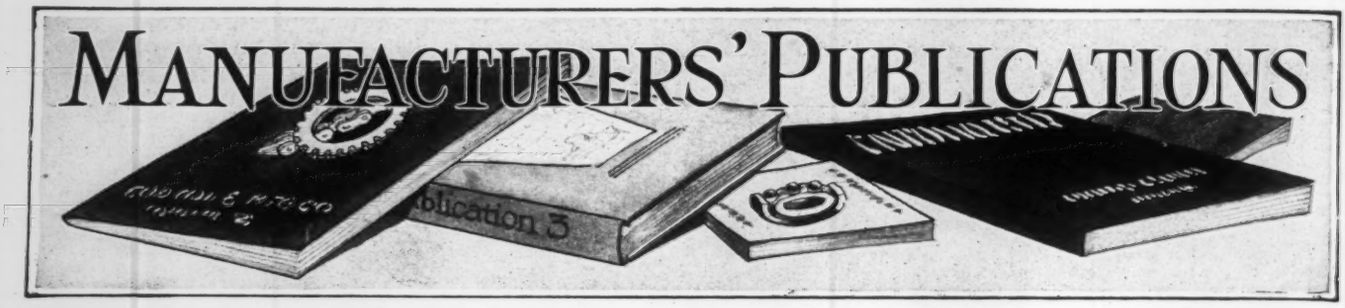
Firm Name.....

Address.....

City..... *State*.....

By..... *Title*.....

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (NICKEL)—International Nickel Co. Inc., New York, has included in the December issue of *Nickel Cast Iron News* an article on the why and how of better machine tool castings. The article considers the requirements of cast iron suited to the general run of machine tool castings, and how these requirements may be satisfied.

ALLOYS (STEEL)—Typical applications of manganese steel, results that may be expected from parts made of this steel, and suggestions for its use are included in the Dec. 24 issue of *The Amsco Bulletin*, published by American Manganese Steel Co., Chicago Heights, Ill.

ALLOYS (STEEL)—Vanadium Corp. of America, New York, has revised and reissued its specification sheets 3B to 9B inclusive, on vanadium steels for various purposes. The sheets cover high test carbon vanadium cast steel for locomotive and other castings, silicon vanadium steel bars for railway springs, helical springs of silicon vanadium steel for railways, chrome vanadium steel bars for railway springs, ellipitic springs of chrome vanadium steel for railways, chrome vanadium steel bars for automobile springs, and elliptical steel springs for automobiles.

CLUTCHES—Magnetic Mfg. Co., Milwaukee, has prepared in bulletin No. 50, a complete description of the construction and operation of its Stearns multiple disk magnetic clutches. The bulletin includes engineering information and shows typical installations.

CONTROLS (ELECTRICAL)—Allen-Bradley Co., Milwankee, has prepared a catalog insert describing bulletin 720EP explosion proof across-the-line starting switches designed for use in class 1, group D, hazardous locations.

CONTROLS (ELECTRICAL)—Magnetic switches which serve as across-the-line starters for induction motors and give temperature overload and undervoltage protection, and induction time relays for alternating current circuits and apparatus are described in two new catalog inserts of the General Electric Co.. Schenectady, N. Y. These inserts are designated GEA-841B and GEA-1314A respectively.

COUPLINGS—Gears & Forgings Inc., Cleveland, has prepared a pamphlet covering Falk flexible couplings for which they are distributors. These couplings, made in standard sizes from 1/5 to 26,000 horsepower at 100 revolutions per minute, allow both lateral and torsional elasticity insuring free float for motor shaft and cushioning the impact of peak loads.

DRIVES—Procedure to be followed in the redesigning of drives is presented comprehensively in the Christmas issue of *The New Houghton Line*, published by E. F. Houghton & Co., Philadelphia.

DRIVES—Worm gear reduction units are presented in complete detail in the new bulletin, No. 112, prepared by Cleveland Worm & Gear Co., Cleveland. The 45-page bulletin, attractively prepared, includes all information the designer may desire in the consideration of these units. Information is included on the materials of construction, principles of operation, typical applications, detailed description of all types, engineering data, and dimensions of standard units. The bulletin is well illustrated throughout.

GEARS—General Electric Co., Schenectady, N. Y., has issued two bulletins describing composition gears manufactured by the company. Textolite gears and gear blanks, made of laminated phenolic compound with a fabric base are described in bulletin GEA-1242A. Fabroil gears and gear blanks comprising cotton fibers laid flat and straight in uniform layers and compressed between steel shroud plates, are covered in bulletin GEA-1236A.

MALLEABLE IRON—Promal, a specially processed malleable iron which is suitable for many industrial castings, is presented in a new book, No. 1250, being distributed by Link-Belt Co., Indianapolis, to engineers and executives. This metal, originally developed for the company's own use, is available in casting form for the use of the designer and producer of machines, parts, etc.

MOTORS—The design, operation, construction, application and maintenance of alternating current induction motors and their controls will be the subject matter of a new publication, *The Motorizer*, prepared by Lincoln Electric Co., Cleveland. Vol. 1, No. 1, published in December, presents an article on "Core Losses in Stator," and a number of inquiries with their answers on specific motor problems.

MOTORS—Geared head motors for gear reduction or acceleration manufactured by Master Electric Co., Dayton, O., are presented effectively in data book section 210 of the company. The booklet, which is well prepared both from an appearance and information standpoint, gives advantages of the use of this type of motor, engineering details of construction and performance, applications, general information, and dimension sheets.

PUMPS—Perfection rotary and vacuum pumps are described in three bulletins, Nos. 284, 300, and 320 recently prepared by Perfection Mfg. Co., Minneapolis. The rotor in the rotary pumps, covered by bulletins 284 and 300, is in the form of a helical internal gear. Four large rugged valves operate automatically to hold the vacuum and release the air in the vacuum type.

A suggestion to machinery designers and manufacturers. How you can increase sales in 1932

Demand in most lines is approaching normal now, and it won't be long before the upward trend becomes definite and production comes into its own again.

In the meantime, alert manufacturers of all kinds of products are out to make the most of the business immediately available.

Realizing that obsolescent equipment will not serve their present and future needs, they are looking for new machines of all types that will enable them to cut production costs without lowering quality standards.

Machinery manufacturers who are taking advantage of this situation are not only profiting now, but will find themselves in a commanding position in their fields when the big drive starts.

One sure way to bring your machinery in line with the times is the use of Timken Tapered Roller Bearings at every point of friction and hard service.

Machinery users know that the presence of Timken Bearings is a sure indication of low power and lubricant demands; highest accuracy; maximum dependability; long machine life with maintenance costs cut to the bone. Machines of every type have a far greater sales appeal when Timken Bearing Equipped.

Timken is the only type of bearing geometrically designed to carry all radial and thrust loads within itself. Furthermore, it is the only type of bearing that can be set up with extremely close radial running clearance and held to that clearance permanently.

The adoption of Timken Bearings does not as a rule necessitate radical changes in existing designs. The Timken Engineering Department will be glad to cooperate in applying Timkens to your equipment. The Timken Roller Bearing Company, Canton, O.

TIMKEN *Tapered Roller* **BEARINGS**